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Plastics

ALING WITH THE MANUFACTURE, USES AND POTENTIALITIES OF PLASTIC MATERIALS

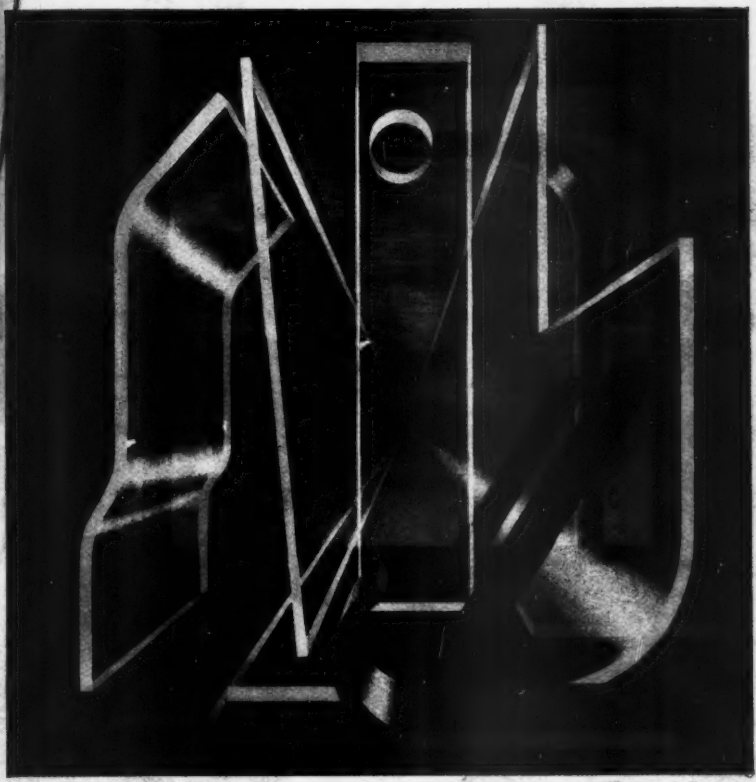


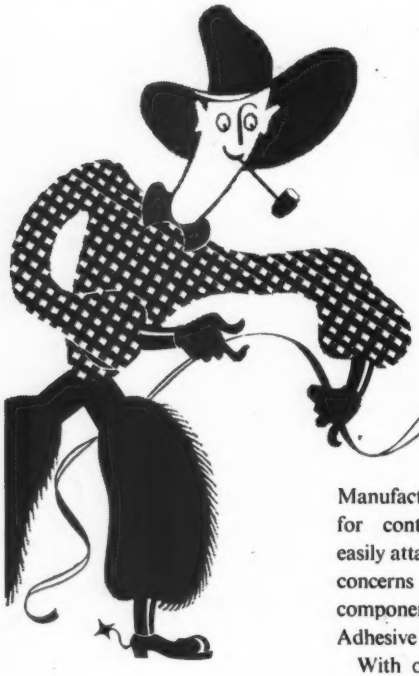
Illustration by Reinganum

Present difficulties limit the colour range of plastic materials produced by I.C.I. Designers and manufacturers can however be assured that the existing range will be increased as soon as circumstances permit.

ICI

P.202

VR v. 11 1947



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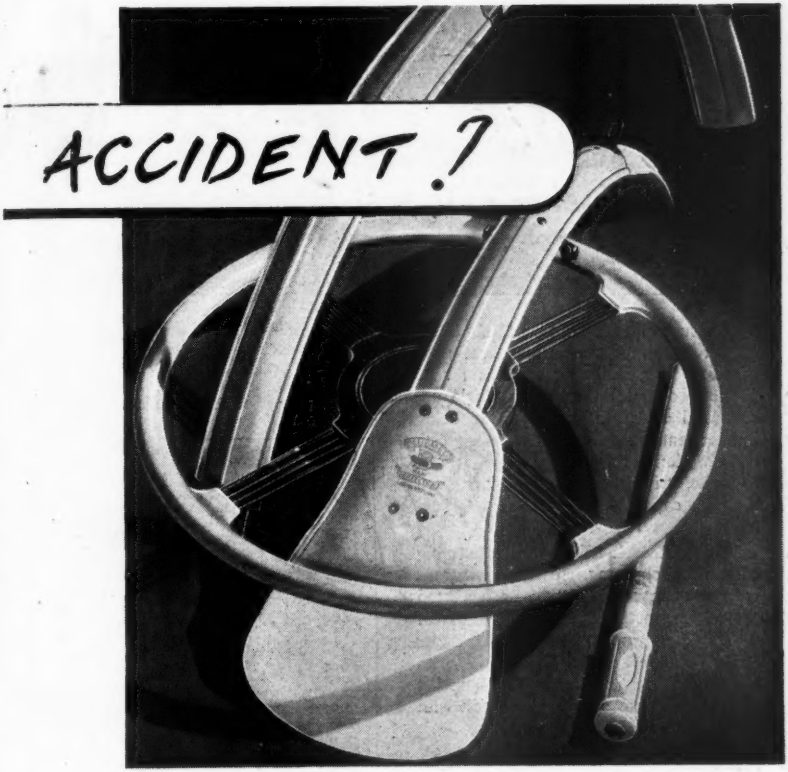

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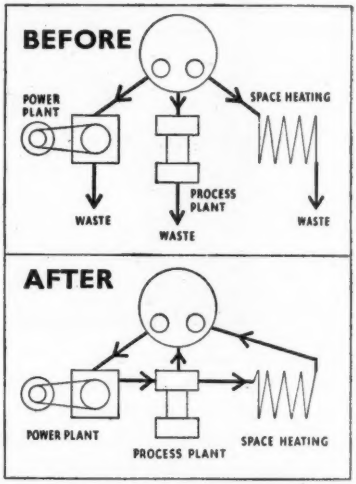

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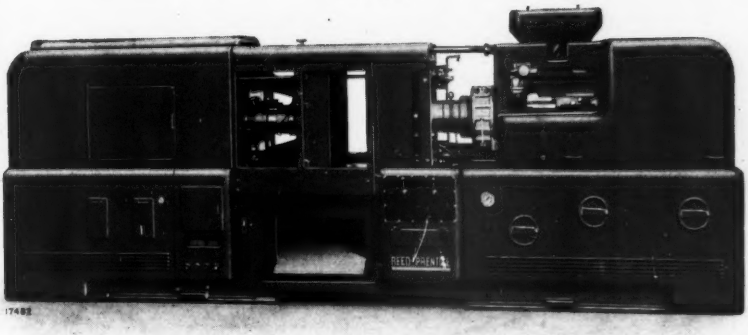

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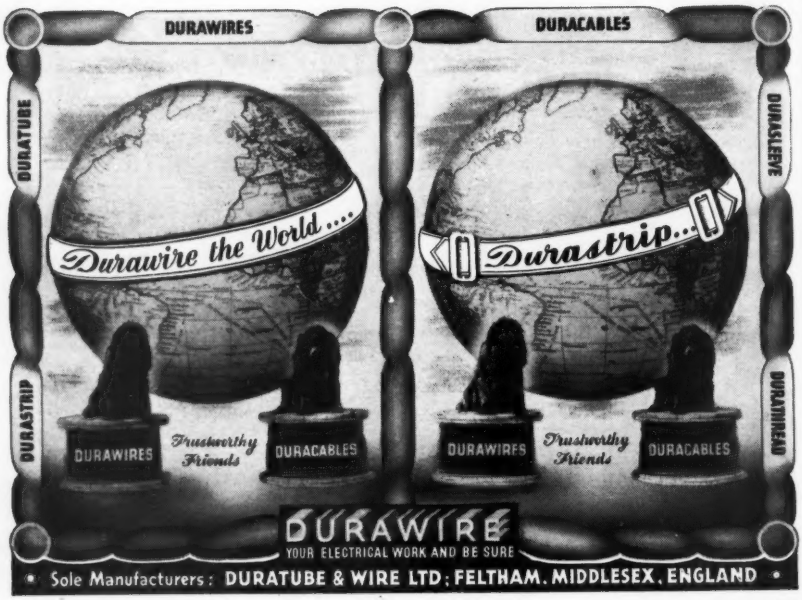

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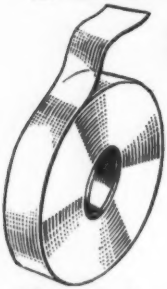

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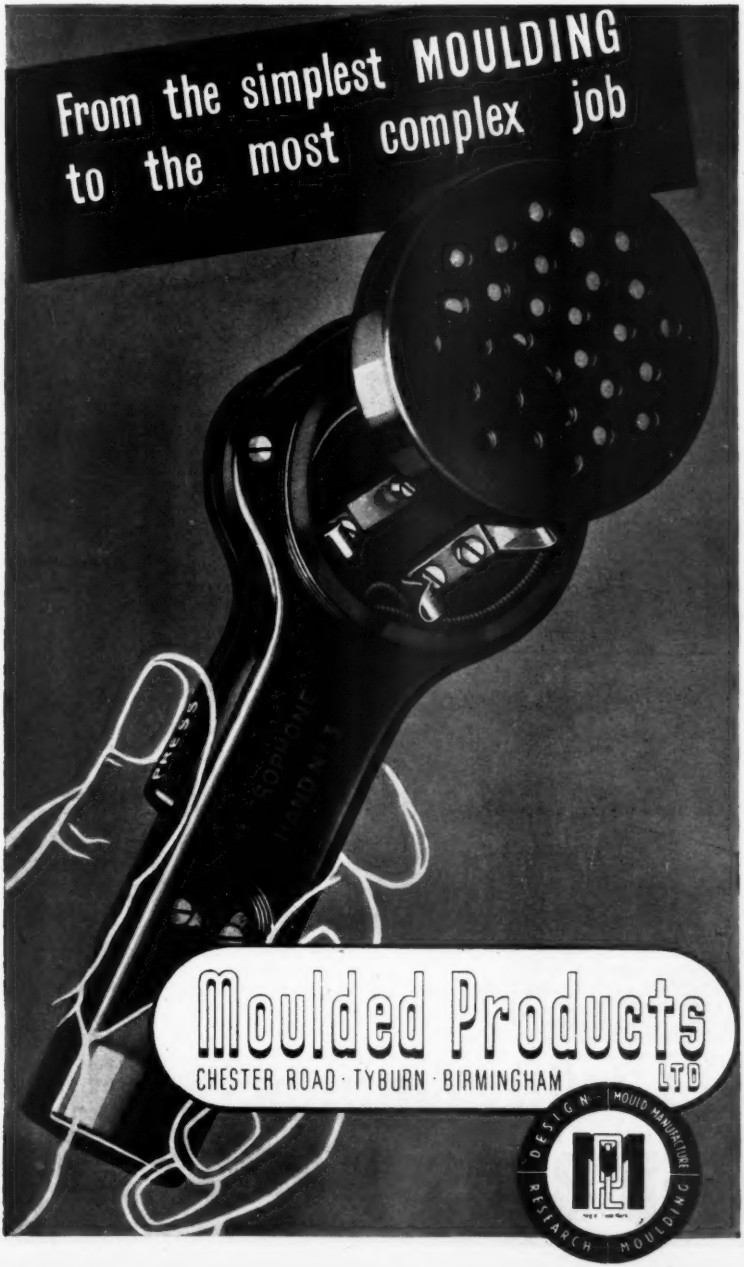
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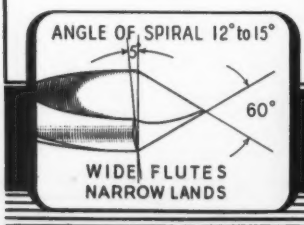

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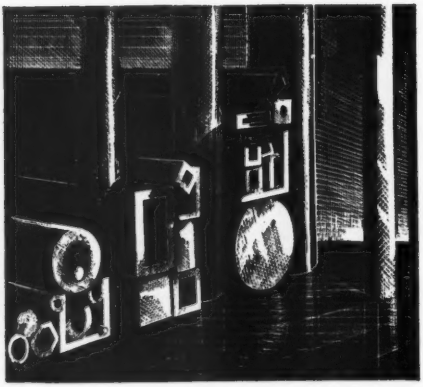

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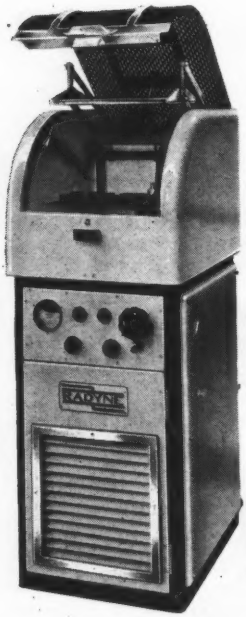

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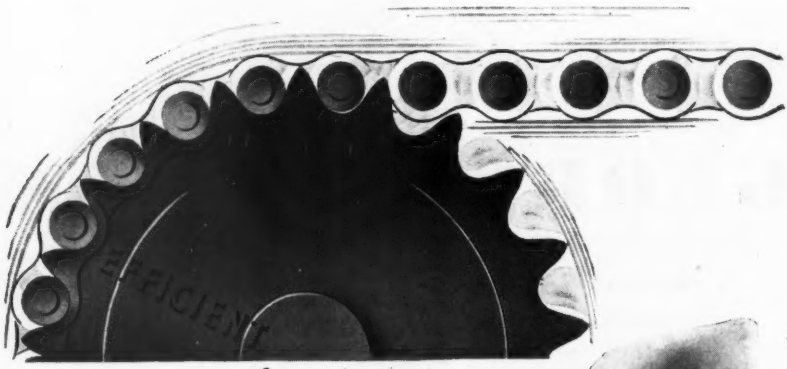

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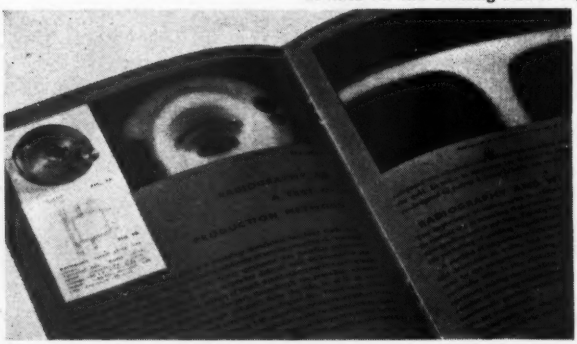

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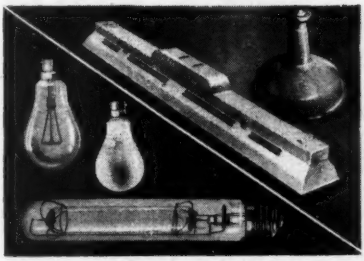

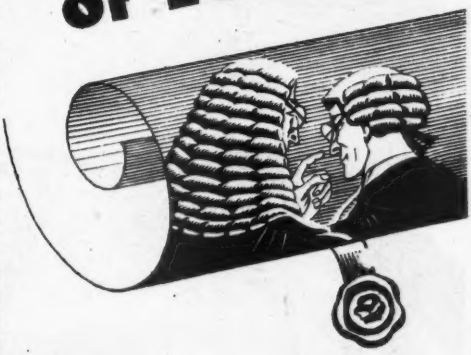

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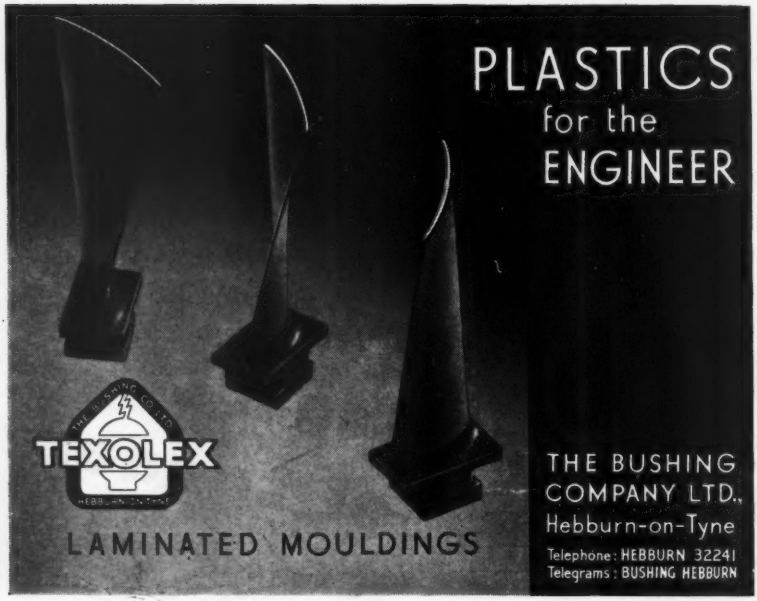

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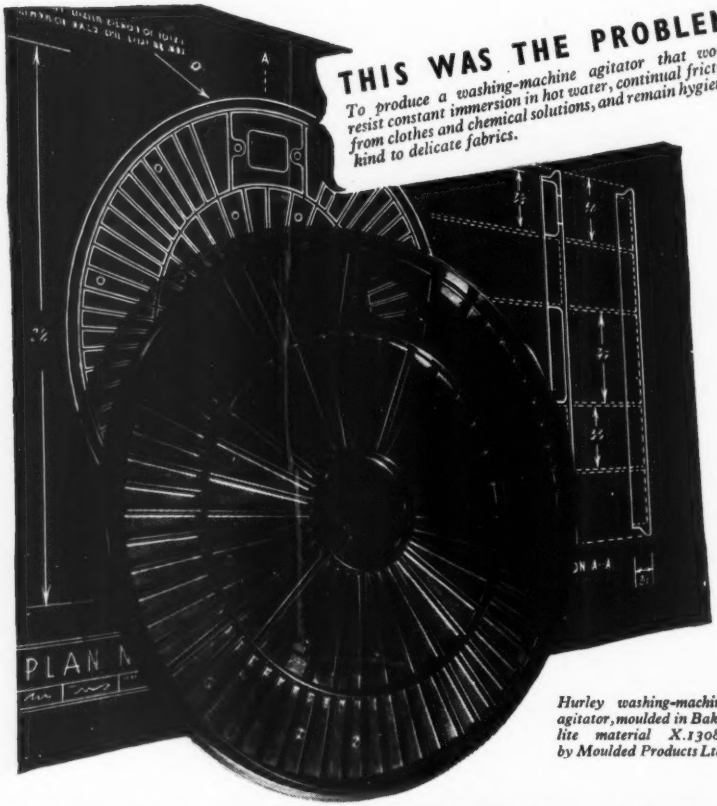
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Vol. XI. No. 116. JANUARY, 1947

Plastics

Dealing with the Manufacture, Uses and Potentialities of Plastic Materials

Proprietors - - TEMPLE PRESS LIMITED
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EDITORIALS

Coal Impasse

A RECENT visit to the North brought us sharply up against a problem which has little to do with plastics, but affects us all who try to understand our present worries.

Before the war the Government of the day was very anxious indeed to help those black spots in the country that had been cursed with long and desperate unemployment. It appealed to manufacturers, especially those in the lighter industries, to install their factories in South Wales, the North-east of England, and those towns in Scotland that had always suffered. We, like most journals, helped in publicizing the importance of such a move to the welfare of the Nation.

Many manufacturers answered the call before and during the war, and the new factories, clean, healthy and safe to work in, have sprung up and have attracted thousands of workers. Some, situated cheek by jowl with coal mines, offer conditions so remote from those we associate with the older industry that it is no wonder that recruitment for mines is at such a low level. One factory we visited was making colourful and beautifully designed plastic ornaments with high precision tools, and hundreds of girls and many returned ex-Service men were gainfully and contentedly employed.

So, too, in the South Wales district have we seen several plastics factories, including one of the largest toy works in the country. It has been stated that 600 workers are at present employed and it is hoped that eventually 1,500 will be absorbed.

We cannot blame any Government for bringing about this condition; indeed, it is praiseworthy, for it has all been carried out with the best of intentions, but one thing is certain in this world—we cannot eat our cake and still have it.

The above examples are, of course, additional to the extremely rapid expansion of old concerns whose production has grown rapidly because of world demand for our goods.

For the time being, however, it may well prove necessary to stop adding to our difficulties for some considerable while, at least until technical improvements in the mines would permit of further drift from them of labour. This also applies to the textile industry, where strong encouragement has often been given to manufacturers to build new factories completely divorced from the textile industry in the cotton towns, so drawing still more workers away from it. As said elsewhere, the answer lies in erecting better and more efficient textile factories which, in their turn, will attract labour or need less labour to run them.

For the present, therefore, we must exert every effort to save heat, power and light in whatever form it takes. Every ton of coal, every unit of electricity and every therm must be carefully hoarded and controlled.

Petroleum Chemicals

IN a previous issue we indicated how the present difficulties in coal production will be partly solved, so far as chemical production is concerned, by bringing to our aid new processes of treating petroleum so that chemicals, hitherto produced only by coal carbonization, can be manufactured. We gave note of a new factory in the Manchester district where this will be carried out.

We have now also news that yet another and even larger petroleum company will shortly announce a similar scheme of development. New ranges of solvents and of phenolics for the plastics industry are scheduled for manufacture.

Gone are the days when it was tacitly assumed that true and complete petroleum refineries could economically be situated only in the countries producing

petroleum. Hitherto petroleum chemicals were developed only in the United States, but happily it has been brought home that transport of the crude is only one factor in the "set-up"—and is now a factor of fastly diminishing magnitude.

Large as our chemical industry has been in the past we are growing so fast that we have definitely taken second place in world production. Concurrently it places us on a much firmer footing than we have ever been, especially as regards plastics and its impact on the coal industry.

Engineering Centenary

ONE hundred years is a very long time in the life of industry, for indeed it takes us back to the very beginnings of the Industrial Revolution and to the great applications of engines which followed the work of Boulton, Wilkinson, Watt and Stephenson.

It was during 1840 that the business of T. H. and J. Daniels was formed in Stroud and in the 60's of the 19th century several beam and other steam engines were produced for the thriving West of England industries. An iron and brass foundry was soon added to the plant and the concern began manufacturing gas plant and valve pumps.

To-day the firm of T. H. and J. Daniels, Ltd., is world-famous as producers of all types of plant for the plastics industry, more especially of pressure moulding and injection moulding presses, the design and capacities of which have improved and increased with the demands of our ever-growing industry.

On December 11 last, some seven years unavoidably late because of war conditions, the centenary was held at the Lilleybrook Hotel, Cheltenham. The guests, who numbered over 200, were received by Mr. J. Stuart Daniels, the chairman of the company, and by Mr. F. L. Daniels, joint managing director.

We have great pleasure in congratulating the company on this occasion and in wishing it a very prosperous and still greater future.

Students' Discussion Group

Experience of class work in the London Polytechnics which provide instruction in plastics has brought to light the need for some organization through which students can help themselves towards a still fuller exploitation of the efforts made by their instructors. A Students' Plastics Discussion Group has therefore been formed to bridge the gap between the syllabus-bound atmosphere of the classroom and the advanced field covered by lectures sponsored by the Institute of the Plastics Industry.

The primary aim of this Group, which has already held three meetings, is the organization of discussions, film shows, visits to factories, etc. Future meetings are to be held every second Wednesday of the month at the Northern, Borough, and South-West Essex Polytechnics in turn. At the Borough Polytechnic on Wednesday, January 15, there will be a discussion upon Cellulose Plastics. The meeting arranged for Wednesday, February 12, will take the form of a technical film show at the South-West Essex Polytechnic, Walthamstow. Future arrangements include the holding of a Brains Trust with reference to plastics. A calendar for the present academic year can be obtained from the Chairman of the Group Committee, Mr. C. W. Welch, "Langdale," Woodside Grove, North Finchley, N.12 (telephone: Hil 2510).

Provided that the support of the individual student is maintained, we feel sure that this new Discussion Group can play a very useful part in stimulating students' interest in the relationship which exists between courses of instruction and the plastics industry proper.

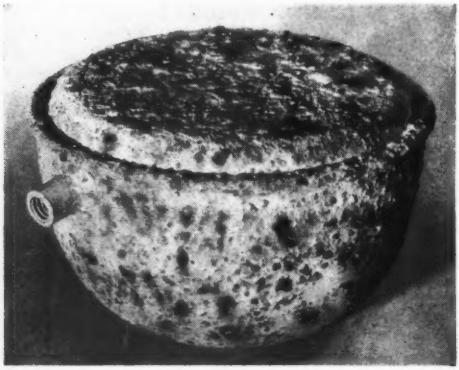
BEETLE MAGAZINE.—We welcome the reappearance, after the lapse of the war years, of this very bright journal and wish it a happy uninterrupted future. The Christmas issue gives a short description by the Chairman of B.I.P. of the improvements that have recently taken place in the factories and of the connections abroad. Mr. Butler, A.M.I.Mech.E., contributes an excellent article on "Flow Marks."

CORRECTION

In one of our recent editorials (November issue, page 566, lines 4-6) we were in error in speaking of Dr. Kind as author of the paper we had in mind. That particular paper, before the London Section of I.P.I., January 13, 1943, was by Dr. G. Tugendhat.

The Mystery of the Busted Flush

THE hero of this sad story is not a poker player, nor is it a noble young plumber who arriving at the scene of disaster and at great risk to his life peers into the overflowing tank, ponders deeply on the vagaries of life, of inanimate objects and the length of the house-



The Villain—rotten to the core.

holder's purse—and following trade union rules, goes home to get his spanner.

No! Indeed I, and I alone, am the hero and the facts are these.

I should explain that I live in an old cottage in which I have recently installed a main water system. The plumber showed me the ball-cock he was putting in "That's copper, that is," he said impressively, letting me in on a trade secret. "Last you a lifetime." It certainly had that lovely reddish colour usually attributed to copper metal, but as I was not quite certain to whose life he referred, I invested in a spare one.

That was early in 1945. About the Christmas of the same year one freezing night I heard an ominous guggle-guggle, followed by a still more ominous drip-drip. At first I put this down to our pet ghost who has a habit of wandering about holding a dagger dripping in blood, but as the dripping accelerated to a steady stream and he hasn't a large supply of blood, I realized it was something more serious.

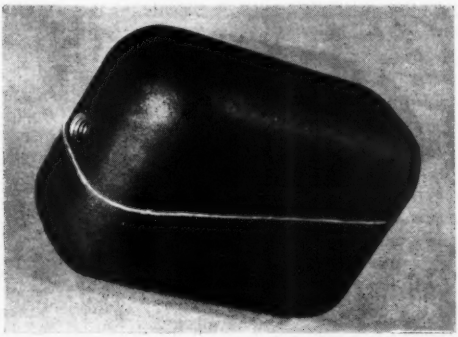
I knew all the answers, for I had got a special mention in my correspondence course in home-plumbing. I shut off the main and dashing up to the loft donned my diving suit, tied up the valve with a bit of string and took off the float, which had completely sunk.

Wretched float! There couldn't have been two-penny-worth of copper on it. It was just a steel pressing with a flavouring of copper on the outside. It had so corroded that water had seeped through and filled it. The overflow pipe had frozen, hence the milk in the coconut, or rather hence the waterfall on the genuine Tottenham Court Road Aubusson carpet.

I replaced the horror with a new float, this time one moulded from expanded ebonite, incorruptible, non-corroding.

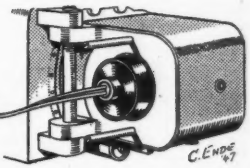
And there it has been serving me well. Only a year so far, but I've had it down and it remains unattacked and looks as if it really will last me my own lifetime

H. DOGSBODDY.



The Hero—incorruptible.

Extrusion



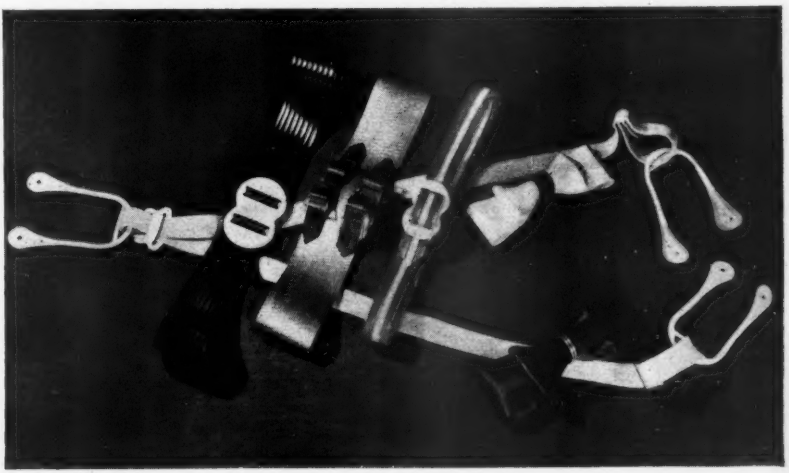
Some general notes on the extrusion of plastics, with special reference to the use of p.v.c. and the activities of Duratube and Wire Ltd.

THE process of extrusion, that is the forcing of a solid in hot semi-solid or fluid form through a die under pressure followed by subsequent cooling to retain the new form, is one of the important methods that has grown rapidly during the industrial age. By its means we are able to produce continuous rods or tubes of almost any desired cross section very rapidly and to avoid much costly working.

Historically speaking, the process is by no means new, for bronze was first extruded about 1870, but it was probably not until very late in the 19th century that cordite or celluloid were similarly treated. Casein followed in due course, and, we believe, more is extruded than is produced in flat sheets or plates. To-day there still exists a tremendous vogue for both celluloid and casein in this form for a wide variety of fancy and other useful goods, fountain pen bodies, buttons, toys, and the like, which has not diminished with the introduction of new materials. Rubber was also among the early materials to be extruded.

To-day the extrusion process covers a much wider field with the introduction of plastics discovered since those early

Change over from war to peace. Women's belts and dress ornaments and men's braces and belts are available in many colours.

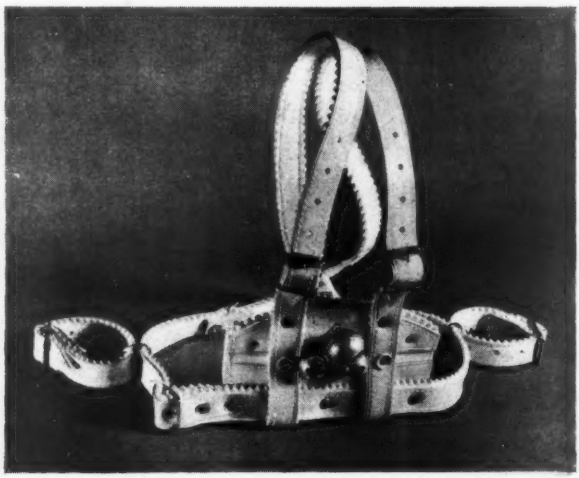


A five-coloured extrusion formed into children's napkin rings with transparent buckle.

days—plastics which possess different properties and which have permitted penetration into many other industries or have made possible entirely new applications.

The first quarter of the 20th century saw the rapid development of the non-natural fibres and the creation of a new branch of what might be called the extrusion technique, for such it truly is, emulating the silk-worm and the spider in the fineness of the filaments. Regenerated cellulose, nitro cellulose and cellulose acetate and casein were highly developed as fibre-forming plastics by the 1920s and 1930s, and by the 1940s they had been joined by nylon, polyvinyl chloride and polyvinylidene chloride. The three last-named made into fabrics have widened considerably the use of fabrics because of their resistant qualities, which the older plastics do not possess in such high degree.

Extrusion " in the mass," to distinguish it from the formation of fine filaments for fabric manufacture, is no different fundamentally from the latter, and all the previously named thermoplastics with the exception of regenerated cellulose have



The main structure of this children's harness is of pink coloured extruded p.v.c.

PEACE WORK IN ACTION.

Extruded p.v.c. strip manufactured by Duratube and Wire Ltd., woven to form the seats of armchairs.

Ingeniously woven transparent and opaque extrusions go to make up these attractive shoes.

been extruded in large thicknesses. Polythene is the latest of the plastics to be so produced.

As for the thermo-hardening plastics, extrusion has been carried out to a growing extent since about 1936 when phenol formaldehyde resins were first so treated in this country to produce large tubular ink-rollers for Gestetner machines. Today, phenolics are extruded for working-up into towel rollers, curtain rods, table edgings, picture frames, and so on.

The chief object of these notes, however, is to give what might be called a progress report of one of the thermoplastic materials, the extrusion of which during the war became, concurrently with the disappearance of rubber from our economy, of paramount importance to the pursuance of our war effort, especially in regard to one section of it, namely cable manufacture. Not that p.v.c. should be regarded merely as a war-time substitute. Indeed, because of its many special properties, its excellent electrical resistance, the ease of its extrusion, and its resistance against chemical breakdown, it stands firmly on its own merits.

Some of its physical properties, the range of flexibility to a hard type, the ease with which it can be coloured or made translucent, provides a raw material of exceptional value.

Several concerns including many of the well-known rubber cable manufacturers soon adopted p.v.c. as their raw material in place of rubber, but so far as the British plastics industry is concerned it seems that Mr. Julius Veit was among the earliest pioneers to show us what really could be done with p.v.c. extrusions. We first met him in 1937 when, with a wealth of European experience, he was producing not only extruded p.v.c.-coated wire for industrial purposes, but a bewildering variety of coloured strips and tubes which he prophesied one day would be used for shoe, bag, toy, chemical and a host of other fancy goods and industrial applications.

During the war he promoted the fortunes of Duratube and Wire Limited, in which p.v.c.-coated electrical wire became one of the main outputs; but while we are convinced that astronomical figures in yardage were produced, that is but history, and we wish to talk about the present production of this concern.

Change over from war to peace does not in the plastics industry usually indicate a change of plant or of method. On the whole there is merely a change of design and ideas, but they are so different that they are worth while relating.

Luckily a change from war to peace means a change to colour in our lives, and p.v.c. can certainly give us that. Extrusion means a strip or braid and so we have a lady's or man's belt of varied

A war-time combination of moulded and extruded p.v.c. — flexible microphone mouthpiece.

configuration and of any colour. And, more fascinating than ever, Duratube has produced a strip made by extruding five or more different colours in the same strip, all welded perfectly to one another yet no colour "bleeding" into its neighbour. It is a noteworthy achievement. With women's and men's belts, men's braces, strips for toy reins and harnesses, wider strips for dress and millinery adornments such as bows, tubular extrusions for carrying liquids (the p.v.c. water pipe is now a possibility), "solid" extrusions for skipping "ropes," and a big variety for the production of fancy shoes, it certainly seems as if p.v.c. has been soundly launched on the commercial seas. Doubtless we shall see new ideas pouring forth as knowledge of this interesting material grows.

There is yet another aspect of this industry which we have left to the last. Duratube and Wire, Ltd., has two associated companies, J. F. Kenure and Co., Ltd., and Dalebrook, Ltd., which specialize in moulding and forming of p.v.c.

Kenure's have long specialized in the injection moulding of p.v.c., producing a wide range of objects from microphone mouthpieces to bicycle hand-grips.

Co-ordination between the three companies enables not only a general interchange of experience but also facilitates new productions. Thus not only do we find the war-time moulded microphone mouthpiece with its attached extruded p.v.c. covered wire shown above, but also a wide range of colourful "flowers" for dress or hat adornment.

Truly at last we are at peace.

Lovely examples of what can be fabricated by a combination of extrusion and moulding techniques.

COLOURING PLASTICS

By William S. Penn, B.Sc.

The new method of colouring plastics here described involves combining reactive groups in the dyes with corresponding groups in the monomers or polymers, thus effecting combination through primary valencies. Improved resistance to fading in sunlight is obtained.

THE commonly adopted method of colouring plastics and synthetic resins is to add dyes and pigments. The defects of this method are many. They include the fading of inferior dyes, the difficulty of matching different batches, and the extra process involved in dyeing fabrics. The processes to be described promise to overcome all these troubles in a relatively simple manner without entailing further expense.

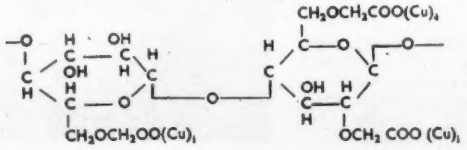
The principle involved is simple, and consists in chemically combining the dye and polymer (or monomer) through primary (homopolar) valencies; thus the two become one inseparable molecule. An exact number of these may be employed in plastics, so ensuring the exact reproductability of shades. The method may be extended to practically all plastics, both thermosetting and thermoplastic, although it is easier with the latter. Precise details, in many cases, have yet to be worked out, but phenolics in the one group and polystyrene in another group have been so coloured. The method may be referred to as "inherent coloration," since the colour is a part of the plastic itself; that is the nomenclature used here. The dyes cannot be removed except by the destruction of the plastic itself.

At the inception of the idea underlying the new method it was obvious that inherent coloration would be a desirable development in the plastics industry. Consideration was, therefore, given as to whether the principle occurred in nature, or whether any previous investigators had made any inherently coloured polymers without realizing the fact.

The result of this search was encouraging. It is well known that phenolic resins have a characteristic colour; secondly, it was known that thick sections of polystyrene have a greenish or bluish tinge. This colour could, of course, be due to the presence of impurities (oxidation products, in the case of the phenolics), but it could also be due to the fact that some of the benzene rings of the constituent molecules had acquired the quinonoid structure.[1, 2] This would probably give them colour. The idea may be represented by reaction[1] where development of the quinonoid structure is one explanation of the mechanism of branching of polystyrene during polymerization.[3]

(1)

Similarly, it is well known that starch forms a coloured complex with the halogens (particularly iodine), and since starch has a high polymeric structure,[4] it is quite possible that we have here an inherently coloured complex. Another example is provided in the case of salts of carboxymethyl cellulose. The sodium salt of this compound is soluble in alkali, but the corresponding salts of the heavy metals are not. In addition, the copper derivative is blue, and the iron (ferric) salt is red.[5] This is the first case where we can propose a formula for a coloured complex, which we know must be somewhere near the facts. (See formula 2.)



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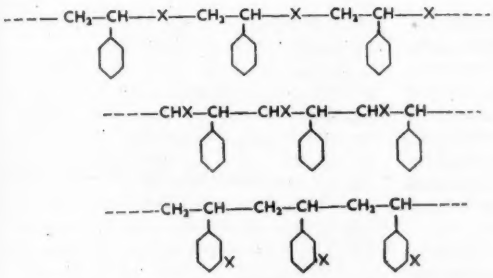


(3)

(4)

(5)

Finally, it may be mentioned that it is claimed by some that the property of polymerization is a fundamental characteristic of some dyes.[6] This statement applies particularly to thionine and methylene blue.

From the above and similar evidence, it seemed clear that it should be possible to synthetically produce inherently coloured polymer complexes.

Theory of Dyes

Every chemical which is coloured is not a dye. In order to be coloured a molecule must have a chromophore group, but in order to be a dye it must also have at least one, but preferably more than one, auxochromes. The $-N=N-$ groups are chromophores and $-NH_2$ and $-OH$ are auxochromes, although there are many other examples.

It is probable that the auxochromes associate in some manner with the substance to be dyed. This association may be chemical or physical; there are theories both ways. There is also a modern theory which maintains that there is no substantial difference between these two states.[7] In any case, the inherent coloration method definitely involves the use of chemical linkages and in part really offers some evidence for the chemical theory, since $-NH_2$ groups can be used in the reactions.

Proposed Methods

In practice, there are many methods which may be used for inherent coloration. These, however, may be resolved into three main types, illustrated by formulæ 3, 4, 5.[8] Here polystyrene is chosen as the polymer, and X represents a dye molecule (no matter what its valency).

In the first method it will be seen that the dye molecule is polymerized into the chain as if the result were a copolymer. In the second method one of the hydrogen atoms of the main chain is substituted with a dye molecule. In the last method the side phenyl groups are substituted. These different methods are applied according to the type of monomer or polymer under consideration.

Formulæ 3, 4, 5 show the place of introduction of the dye; it is now necessary to consider the method of introduction. In this, chemical groups in the dye are made to react with chemical groups in the polymer. These groups may have to be introduced especially for the purpose, but in many cases they are already present.

In the following formulæ Y represents a polymer molecule and X again represents a dye molecule. One possibility of combination is as follows:—

$$XONa + ClY \longrightarrow XOY + NaCl \qquad (6)$$

It will be seen that an ether type linkage is formed in this instance. Reactions 7, 8, 9, 10 and 11 illustrate other methods, although this by no means limits the possibilities.

$$XCl + NaOY \longrightarrow XOY + NaCl \qquad (7)$$

$$XCl + 2\,Na + ClY \longrightarrow X-Y + 2\,NaCl \qquad (8)$$

$$XNH_2 + ClY \longrightarrow XNHY \longrightarrow HCl \qquad (9)$$

$$XNH_2 + COOHY \longrightarrow XNHCOY + H_2O \qquad (10)$$

$$XNH_2 + ClSO_3Y \longrightarrow XNHSO_3Y + HCl \qquad (11)$$

Polymerizable Dyes

The method represented by formula 3 is probably the most convenient if not the simplest to apply in practice. It is obvious that to put the method into

operation, it is necessary to make the dye polymerizable. Some dyes will polymerize slightly quite naturally (loc. cit.), but this is not sufficient for the method under consideration. It is, therefore, necessary to attach a polymerizable group to the dye. Vinyl chloride was used for this purpose in practice, since it was such a reactive and convenient monomer to handle.

Two methods of effecting this particular combination were used. The first was the ether method already illustrated in reaction 6:—

$$XONa + ClCH = CH_2 \longrightarrow XOCH = CH_2 + NaCl \quad (12)$$

The preparation of a polymerizable dye by this method will be described later, using the sodium salt of hydroxy azo benzene. The other method used was the treatment of the chloro derivatives of both the monomer and dye with sodium (reaction 7).

Polymerization

The polymerizable dye produced by the above technique (vinyl hydroxy azo benzene) had a yellow-reddish colour. It could be polymerized by itself with some difficulty to yield a deeply coloured polymer. The latter would form a solid, but the molecular weight varied a great deal, depending on the catalyst used and the temperature employed.

Prolonged polymerization without catalyst (several days) yielded a polymer of high molecular weight. At polymerization temperatures between 100 degrees and 150 degrees C., in the presence of a catalyst, however, the molecular weight was low. Many catalysts were tried and iodine was found to be fairly effective. This may seem strange, but it is not unusual among the vinyl ethers.[9]

To obtain satisfactory polymers by the above method would be unsatisfactory and uneconomic. Co-polymerization reactions were, therefore, carried out. Five per cent. polymerizable dye was co-polymerized with styrene (95 per cent.) at 100 degrees C., in presence of 0.1 per cent. benzoyl peroxide. Coloured polymers of about 80,000 molecular weight were produced. Even less dye than this produced satisfactory colours.

It will be seen that this particular process is entirely satisfactory. Considering the economics of the method, there is no increase in the number of processes, or in the case of post-polymerization dyeing methods there is a reduction of one. The polymerizable dye becomes one of the ingredients of polymerization, which is a very satisfactory arrangement.

Practical Methods

The two chemicals required for this reaction are vinyl chloride and the sodium salt of hydroxy azo benzene. The theory of the process is illustrated in reaction 13.

$$CH_2 = CHCl + NaOC_6H_4N : NC_6H_5 \longrightarrow NaCl + CH_2 = CHO\langle\bigcirc\rangle N : N\langle\bigcirc\rangle \quad (13).$$

Six hundred and sixty parts by weight of the sodium salt of hydroxy azo benzene should be dissolved as far as possible in 2,500 parts ethyl alcohol. The solution is then placed in an autoclave, since pressures of several atmospheres are reached during the reaction; 187 parts by weight of vinyl chloride are then added with stirring and the mixture is heated at about 180 degrees C. for several hours. The reaction is complete when the solution is very slightly alkaline or neutral.

On removal from the autoclave, the solution should be allowed to cool, when sodium chloride separates out. The remaining solution is steam distilled, when the alcohol, and any by-products formed during the reaction (e.g., vinyl ethyl ether), are removed. The residue is extracted with ether; evaporation of the ether gives the polymerizable dye, and the process may be repeated any number of times to obtain a better degree of purity.

In the case of some dyes or monomers used in a reaction of the above type, it may be difficult to effect complete solution or to find a common solvent. Here it is permissible to use suspensions, since the reactions do take place in this medium.

When the polymerizable dye has been

made, it may be co-polymerized by the usual techniques and no special instructions need be given in this connection. No trouble is likely to be encountered due to premature polymerization caused by the heat of the reaction; at least not with the kind of dyes described.

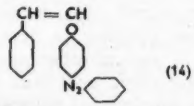
Chain Substitution Technique

This method is illustrated in reaction 4 and consists in substituting one of the hydrogen atoms of the chain with a dye molecule. The reaction may be accomplished by two main methods: (1) For a monomer, followed by a subsequent polymerization, and (2) for the polymer itself. There is not a great deal of difference between the two methods.

In the case of method 1, the most convenient molecules to use are the β-substituted styrenes. Any of the halogeno types may be employed, although β-bromo styrene is probably the most reactive. The coupling may be brought about by using either the NaOX or the ClX type of dye. Refluxing at elevated temperatures is necessary in the case of both, with the addition of sodium in the case of the ClX dye.

Once again little trouble is likely to be experienced with premature polymerization, unless the temperature becomes too high or the period of heating too long. These conditions can only be found by experience with each dye, since they vary in their rate of reactivity. Another point which should be mentioned is that it is little use employing a dye containing a chlorine atom, where this is only present in the form of a hydrochloride; obviously, the chlorine atom must be linked to the dye molecule by a primary valency.

The dye formed in the above reaction has the formula:—



(14)

Polymerization

Some difficulty was experienced in polymerizing the dyes described in the previous section. As such, of course, they may be treated as polymerizable dyes, and the reticience in polymerization is not unexpected, since it is difficult to polymerize β-substituted styrenes. When polymerization takes place in the presence of benzoyl peroxide as catalyst and at about 100 degrees C., molecules of low molecular weight are formed. These vary from dimers, trimers, etc., to polymers of 1,000-2,000 molecular weight.

This was investigated further, and it was found that the degree of polymerization was reduced with increasing temperature of polymerization. The effect of reducing temperature was therefore tried, and the molecular weight did increase when this was reduced. At 0 degree C. molecular weights of about 20,000 were obtained. The phenomenon may be compared with the polymerization of isobutylene at low temperatures.[10]

When co-polymerization techniques were examined very little trouble was experienced. Once again it proved possible to co-polymerize 5 per cent. of the dye with 95 per cent. styrene, and co-polymers of quite high molecular weight were obtained. In this instance no special precautions need be described.

In method 2, the β-substituted polymer itself is dissolved in a solvent and reacted with NaOX or ClX dyes, exactly as in the case of the polymer. The reactivity of the chlorine atoms does not appear to have been reduced in the case of the polymer, and no special precautions need be mentioned, except that, to obtain polymers of high molecular weight, low temperatures must be employed for polymerization.

Side Chain Substitution

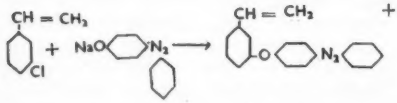
This is the method illustrated by reaction 5. Once again it may be carried out in two ways, the first by using the monomer, and the second by using the polymer.

In method 1 the first requirement is a monomer which is substituted in the phenyl group. Any reactive group may be employed, but the halogens were again found to be the most convenient. Respecting these the ortho meta or para types can be employed, although the

ortho and meta derivatives give the polymers with the highest molecular weight. This is because they do not increase the length of the phenyl radical.

It must be noted that these nuclear substituted styrenes are very reactive and polymerize rapidly—sometimes even more so than styrene itself. In coupling the dyes, therefore, care must be taken to avoid polymerization. To achieve this the temperature must be kept as low as possible during the coupling reaction, and an inhibitor must be used (for example, β phenyl naphthylamine). When these precautions are taken it is possible to carry out the coupling reaction exactly as by the previous methods.

These coupling methods once more, involve dyes of the types NaOX and C1X, and reactions similar to the following may be carried out:—



(15)

Refluxing (at about 60 degrees C.) may be carried out with or without sodium, according to the type of dye employed.

Polymerization

Once the dye has been made no trouble will be experienced with polymerization. Up to 1 per cent. benzoyl peroxide may be added as catalyst, and even the pure dye polymerizes to give molecules of quite high molecular weight (up to 70,000). This naturally depends on the bulkiness of the dye, since the rate of polymerization is reduced somewhat with increasing size.

However, it would be too expensive and quite unnecessary to make polymers with the dye only. It may, therefore, be co-polymerized in the usual manner. Five per cent. or less is needed to give a satisfactory colour. These nuclear substituted styrenes polymerize just as readily as if no dye were present.

In method 2 the production of inherently coloured complexes from the polymeric nuclear substituted styrenes is just as simple as producing them from monomers.

The coupling is again effected by refluxing the appropriate chemicals. In this instance, however, it may be noted that the temperature may be increased as high as is required. In fact, a mixed monomer/polymer method may be employed. The reaction can be started by using the monomer at elevated temperatures. As the coupling takes place, polymerization occurs also, and therefore both are coloured to a degree.

Modified Nuclear Methods

There is a very important variation of the method illustrated in equation 5 and already described. It consists in using the phenyl radicals of the polystyrene chain as a part of the dye;[11] in other words, an amino group is introduced into the phenyl radical; this is diazotised, and then coupled with other chemicals. This method may be applied to plastics containing phenyl radicals, and it is proposed to describe two types of resins—polystyrene and the soluble phenolics.

Colouring Polystyrene

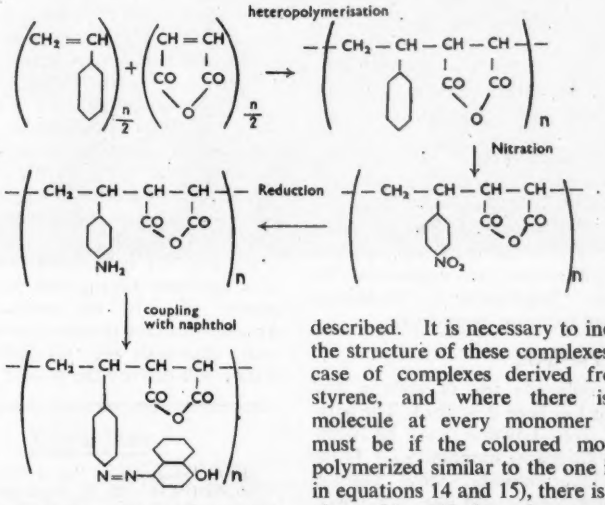
There are two methods of doing this. The first is to use the heteropolymer styrene/maleic anhydride; the second, to use polystyrene itself. The first method is probably the easier to apply, the difference being the ease of solvation in the respective solvents employed. Incidentally, it may be mentioned that it is often difficult to find appropriate solvents in these dye methods, and suspensions are often just as good.

Employing the heteropolymer method, the styrene and maleic anhydride are heteropolymerized by heating under reflux. The polymer is then purified, dissolved in hot nitrobenzene, nitrated with fuming nitric acid and finally the polymer is precipitated in water. Some of this nitrated heteropolymer is dispersed in 1-4 dioxane. It is then reduced to the amino compound by the use of tin and hydrochloric acid. The reduced

polymer is precipitated in acetone and will dissolve in water.

Some of the amino polymer so produced is dissolved in water, acidified with hydrochloric acid and diazotised with sodium nitrite, cooling continually with ice. When coupled with α-naphthol, a brilliant red colour is obtained. Many other coupling reagents may also be employed, and it will be seen that a wide variety of coloured polymers may be produced. Examples of the coupling reagents (these apply to all the methods) are aromatic diamines, alkylated aromatic amines, phenols and naphthols and their sulphonic acid derivatives, diphenylamine and so on.

The following is the flow sheet for the production of the above products:—



If straight polystyrene is to be used, it may be added direct to nitric acid for nitration. After washing free from acid, reduction and diazotisation may then be carried out much the same as before.

Colouring Phenolics

Only the soluble phenolic resins may be coloured in the manner to be described. Half of the resin is added to fuming nitric acid. When precipitation begins more acid is added to the remainder of the resin. The mixture is allowed to cool, and as it does so the nitrated resin is precipitated. The mixture is then poured into water and the bright yellow resin filtered off.

Reduction may be carried out by dispersing the nitrated resin in 1.4 dioxane and treating with tin and hydrochloric acid. The resin is then precipitated and washed. A portion of this reduced resin is suspended in water, acidified with hydrochloric acid, and cooled. It is then diazotised by the addition, with stirring, of a 10 per cent. solution of sodium nitrite. With α-naphthol, a deep red insoluble resin dye is produced.

The most important methods of effecting inherent coloration have now been described. It is necessary to inquire into the structure of these complexes. In the case of complexes derived from polystyrene, and where there is a dye molecule at every monomer (as there must be if the coloured monomer is polymerized similar to the one illustrated in equations 14 and 15), there is no doubt about this, and the polymers must have the structure postulated in equations 3, 4 and 5. Naturally, the usual cross-linking and branching phenomena will occur.

In the case of co-polymers, however, the situation is somewhat different. Distribution data can be obtained and there are two types. First of all, there is the normal distribution of the molecular weights of the polymers about the average. Secondly, there is the distribu-

tion of the dye throughout the co-polymer. The 5 per cent. dye molecule should obviously be distributed randomly and according to chance throughout the molecules. However, fractionation does show some differences, and it is possible to detect slightly different shades between the fractions. Nitrogen analysis has shown that the molecules of least molecular weight contain the least amount of dye molecule. In general, however, the same rules which apply to normal co-polymers apply to the styrene/dye co-polymers.

Change in Polymers

It might be expected that the incorporation of these polymerizable dyes, and attaching dyes to the polymeric chains, might have some form of effect on the polymers. However, this has not been found to be so.

In the case of the co-polymerization reactions, the co-polymers have been found to have the same molecular weight which they would have had if the styrene had been polymerized by itself. In instances where reactions take place which could possibly degrade the chains (i.e., nitration), very little change seems to occur. The bond strengths are such that it is difficult to cause degradation by such means. Dry heating at 300 degrees C. is needed to cause degradation.

Types of Polymers

So far only the use of styrene and polystyrene has been described. The polymerizable dyes, however, may be incorporated with many monomers. These include vinyl chloride, vinyl acetate, methyl methacrylate and like monomers, and chloroprene and butadiene in the dienes. In the case of the other methods (except the use of the polymer as a part of the dye), any one may be used which has a group capable of reaction with a corresponding group in the dye molecule. This method can be used in the case of cellulose compounds.

Where the polymer is used as a part of the dye, it is necessary for the phenyl group to be present and to be introduced. The following are the polymers which have been used: styrene-methyl acrylate, polydihydronaphthalene, dihydronaphthalene, maleic anhydride, styrene-methyl methacrylate, coumarone indene resins and polyacrylanilide, etc. It may be noted in connection with polymers that do not have phenyl groups (the acrylates) that some styrene may be copolymerized with the monomer, and this supplies the necessary phenyl groups for the reaction.

Practically any type of dye may be used; at least, all those which can be given suitably reactive groups. Reds and yellows are the easiest colours to employ.

The advantages of this new method may be summarized as follow:—

(1) In the case of those polymers which require post-polymerization dyeing, the new method of colouring should be a great boon. Although it has not yet been tried, it should be possible to inherently colour nylon fibres. The original molten polymer itself would be coloured.

(2) If it is required to duplicate shades, this is much simpler, because a more or less exact number of dye molecules can be introduced into each polymer chain.

(3) Since the dye is a part of the molecule, it seems to be better protected from attack by sunlight.

(4) The dye is generally more stable; it is the same throughout the section of plastic (i.e., is not surface dyeing). Abrasion cannot remove the colour; corrosive chemicals will only destroy the dye if they will destroy the plastic.

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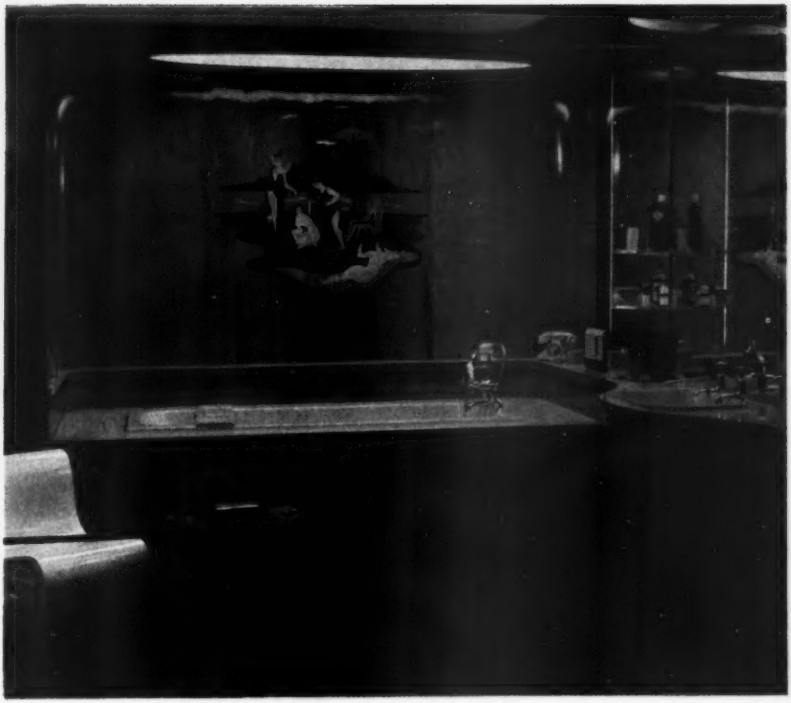
(1) *F. Pollak,* U.S. *Pat.* 1,211,227 (1917); 1,369,352 (1921). **(2)** *H. Staudinger and G. V. Schulz,* "*Ber.*," 1935, 68, 2,320. **(3)** *W. S. Penn* "*Plastics*," 1944, 8, 87. **(4)** *W. O. Herrmann and W. Haeknel,* "*Ber.*," 1927, 60, 1,658; *K. H. Meyer, H. Hopff and H. Mark,* "*Ber.*," 1929, 62, 1,103. **(5)** *C. B. Hollanbaugh, L. H. Burt, A. P. Walsh,* "*Ind. Eng. Chem.*," 1945, 37, 10. **(6)** *E. Rabinowitch and L. F. Epstein* "*J. Am. Chem. Soc.*," 1941, 63, 69. **(7)** *H. F. Willis, J. O. Warwicker, A. Standing and A. R. Urguhart,* "*Trans. Farad. Soc.*," 1945, 41, 8 *and* 9; *J. B. Speakman,* "*J. Soc. Dyers Col.*," 1925, 41, 172. **(8)** *B. P. Appl.* 3,078/46. **(9)** *Chalmers,* "*Can. J. Res.*," 1932 7,464. **(10)** *B. P.* 401,297. **(11)** *B. P.* 524,996 (1940).



The bath so symbolic of civilization was highly developed in Minoan, Etruscan, Greek and Roman times. But it has been the so-called Plastics Age that has shown how to create a bathroom that is not reminiscent of a cold aseptic mortuary, but warm in colour as well as in temperature, as water-resisting and cleanly as ancient Parian marble.

Shown at the recent "Daily Graphic" Plastics Exhibition. Constructed in Warerite laminated plastics, the birchwood veneers having original murals by A. E. T. Barbosa. Ivory Warerite is used for the chair.

World's Industry Employs Plastics

GENERAL ENGINEERING

Cast resin moulds and dies for the aircraft industry are produced at the Buffalo plant of Curtis Wright Corporation, which consumes about 1,700 lb. of liquid casting resins per day. Phil Glanzer reviews the techniques applied for producing these moulds and dies. (Machine Tool Blue Book, 1946/**42**/281.) **Fiberglass-reinforced plastics,** as exploited by the North American Aviation Inc., are discussed in an illustrated article (" Materials and Methods," 1946/**24**/1,182). A wing bomb-rack fairing, made of fiberglass plastics, proved lower in cost than the metal fairing. Other interesting applications include heat and vent ducts for aircraft. **Polythene sheeting and tubing,** for the protective packing of war equipment and its transference to numerous peace-time products, are the subject of data by Plastics Development Division of Visking. (" Materials and Methods," 1946/**24**/1,188, 1,189, Nov.) **Water-like synthetic resin** adapted for casting has been developed by Duorite Plastic Industries, Culver City, California. This product is a modification of "Plasti-tool" high-strength phenolic used for aircraft tooling during the war. The special characteristic of the new resin is the elimination of air bubbles, which have hitherto made the production of complex plastic castings extremely difficult and sometimes impossible. (" Machinery," New York, 1946/Nov./218.) **Silicone products** have basic properties which make them suitable for use under severe service conditions to which mechanical and electrical equipment are subjected in mines, metallurgical mills and smelters. (" Engineering and Mining Journal," 1946/Nov./72.) **Contact moulding procedures** were developed during the war for the production of shields to protect the fuel supply in aircraft. Later, the same resins found extensive use for body armour and housing for radar equipment. The chemical nature of these thermosetting vinyl polymers is discussed by E. L. Kropa; he deals with their similarities and dissimilarities to conventional plastics (Electrochemical Society Preprint 90-29, Oct 16). The different processes employed for these contact-laminated resins are compared. **Low-pressure laminating** in the plastics industry is subject of thesis by Warren C. Hyer at Graduate School of Business Administration, New York. The investigation deals with materials and equipment applicable for low-pressure moulding and the production of standard stock sheets. Low-pressure methods of recent design have been analysed as to their efficiency. (Index No. 8-8, Master Theses List No. 3, Library of Industrial Research, Chicago.) **Neoprene-bonded polishing wheel,** used for the finishing of stainless steel and other metals, has been developed by the Manhattan Rubber Division (U.S.A.). The wheel is provided with finer abrasive grain sizes, or with soft abrasives, such as pumice or rotten stone. The peripheral speed is limited to 3,000 ft. per min. (" Foundry," 1946/Nov./234.) **Redux bonding** as a significant advance in aircraft construction is described in " Aero Research Technical Notes," Bulletin No. 48 (Dec., 1946). Data is given for the comparison of riveted, spot-welded and cemented joints, with details of tests during the large-scale production of an all-metal machine employing an adhesive in place of the usual rivets.

MISCELLANEOUS

Adhesives of interest to the motor-car and aircraft industries have been reviewed by D. L. Swayze, who goes into fundamental problems. (" S.A.E. Journal," 1946/**54**/412.) The continuity of bond causes an equal distribution of the load, eliminates stress concentrations, and offers a solution to crippling or ultimate buckling stresses. **New plastic material** (Textolite, No. 1422) with characteristics said to be useful for parts in television equipment, frequency modulation radio and radar sets, and other ultra-high-frequency insulating applications is produced by Plastics Division of General Electric Co., Pittsfield, Mass. (" Materials and Methods," 1946/**24**/1289.) **Centreless profile grinding** of fountain-pen barrels is performed on automatic controlled-cycle centreless grinders at a rate of 800 finished barrels per hour. Italian makers formerly produced about 12 barrels per hour by diamond turning. (" Mechanical World," 1946/**120**/632.) **Organo-silicon polymeric substances** as electrical insulating materials are discussed by S. L. Bass, M. J. Hunter and T. A. Kauppi, of Dow Corning Corporation (Electrochemical Society Preprint 90-19, Oct. 16). **Preheating oven,** specially designed for extraction of moisture from thermoplastic materials and for preheating prior to feeding into the hoppers of injection-moulding presses, has been developed by Despatch Oven Co., 619, S.E. 8th Street, Minneapolis 14, Minn. The oven is automatically controlled; its capacity is 100 to 700 lb. of material per 8-hour day. (" Modern Machine Shop," 1946/Nov./322.) **Prevention of dust explosions** in the plastics industry is subject of a new code (ASA, Z.12.16-1945) issued by National Fire Protection Association, Batterymarch Street, Boston 10, Mass. The code is a useful guide to the elimination or reduction of dust-explosion hazards inherent in manufacture of plastics, including the handling of raw materials. It deals with electrical equipment, communications, preventive measures against explosions, means for minimizing the effect and extent of explosions in dry powder processing, and fire-extinguishing systems. An appendix gives a typical calculation for explosion vent sizes. **Shatterproof plastic goggles** provide a necessary protection for the eyes of laboratory workers; in some cases it is preferable to wear safety visors, which shield the eyes and can easily be lifted over the forehead when desired. (" The Laboratory," 1946/**16**/58.) **Developments in tool engineering** has accelerated progress in plastics, according to Th. A. Dickinson, who has reported on visits to over 100 works. He refers also to the centrifugal casting of phenolics, as carried out at Rezolin Co., Beverly Hills, California. (" Tool Engineer," 1946/Oct./36.) **New hand lathe** for plastics components, such as buttons, has been developed by E. H. Jones (Machine Tools), Ltd.; the spindle collet can be opened by a foot-operated lever (" Machinist," 1946/**90**/1446).

SOURCES OF REFERENCE.

We wish to remind readers that the sources of reference from which these pages are compiled are not, in general, retained in this office. We cannot, therefore, undertake to supply such originals. Nevertheless, most of the foreign journals referred to are available in the Patent Office Library (Southampton Buildings, Chancery Lane, W.C.2) and in the Science Library (South Kensington). Photo-duplicated copies of articles may be obtained from the Photostat Dept. of the Patent Office.

Pair of contact lenses in various stages of manufacture.

Inserting and removing the lens is a simple operation.

Contact Lenses Made in Canada

CONTACT lenses are not novel; they were originally made of blown or carefully ground glass. The danger of serious injury to the eye from breakage of such lenses, however, has been eliminated by using plastics in substitution of glass.

In Montreal, the Obrig Laboratories have greatly developed the production of these lenses, using "Lucite" acrylic resins. They have brought the technique of production to high perfection. As no two eyeballs are ever alike, individual castings must be made. The eye is first anæsthetized, the eyelid is drawn back, and special jelly (Mouldite) is placed over the eye to obtain the required impression, from which casts of the eyeball are subsequently made in dental cement, supplementing the patient's optical prescription.

First steps in the actual making of the contact lens is to heat a small square of "Lucite" acrylic resin and mould it over each casting. After rough trimming, the next operation is the hollowing out of the centre part of the lens so that it will not touch the cornea. This is followed by the grinding and polishing of the outside to meet the exact requirements of the prescription.

Each lens is then examined by the use of a microscope-like instrument (known as the lensometer) to check prescription requirements. Under examination the lens is filled with a fluorescein solution, which gives colour interference and so indicates ill-fitting spots.

In correct use these contact lenses never touch the cornea; they merely fit quite comfortably on the sclera, or white of the eye. A special solution has to be employed as a lubricant. The length of time that such lenses can be worn without any discomfort varies with the individual. Some persons have worn them for as long as two weeks, but the average duration is 5 to 8 hrs. The reason for this time variation is the absorption or loss through evaporation of the lubricating solution. Mr. Obrig is still experimenting with various liquids in the hope of perfecting one which will not be absorbed nor lost through evaporation.

LETTERS TO THE EDITOR

Correspondents are reminded that a stamped and addressed envelope should be enclosed in all cases where a personal answer is desired.

Preheating P.V.C. Before Calendering

Sir,—I was interested to notice your recent editorial reference to the heating of synthetic resin powders by high-frequency currents.

Radio frequency preheating has been used for some time by the plastics industry for the manipulation of the thermo-setting materials, such as phenol-formaldehyde and urea-formaldehyde. Very substantial advantages have been gained in the direction of reduced curing cycles, increased physical and electrical properties, and better maintenance of fine tolerances on dimensions.

A more recent application of R.F., which has been developed by Delapena and Son, Ltd., is its application to the preheating of p.v.c. material prior to the calendering process. The application of the R.F. preheating process results not only in the complete elimination of the intermediate hot rolling operations, but also gives more even heating of the material with complete absence of overheating and discoloration.

Briefly, the process consists of placing the p.v.c. in powder or granular form into suitable containers, and heating it to the required temperature by placing the containers between the electrodes of the R.F. generator. At the end of the heating cycle the material is emptied from the containers in the form of "cakes," and these are fed direct to the calendering rolls. This enables at least two mixing and hot rolling operations to be dispensed with, with a resultant reduction in the production costs of the p.v.c. sheet.

The standard Deltron D.10 preheater can be used for this application without any modifications. This machine is capable of handling the granular material up to a maximum of 2 lb. per minute per 100 degrees C. If the feed to the calenders is known, it is possible to determine the number of preheaters which will be required.

Owing to the even heating which occurs, it may be possible to avoid the necessity of adding the metallic salts which are admixed with the p.v.c. to prevent overheating and scorching in the hot mixing. However, no definite information is available regarding this point; it is a matter rather for the material manufacturer rather than the manipulator.

The operating cost of the Deltron D.10 preheater is approximately 1s. 6d. per hour, or 0.15d. per lb. of material heated: these figures take into account power consumption, valve replacement, and write-off of capital expenditure in four years. It will readily be appreciated that this figure is very low when compared with the labour costs and overheads normally associated with running two hot rolls.

In addition to this, the mixing machines often prove to be a production "bottleneck" and cannot operate sufficiently fast to keep the calenders operating all the time. As a result, oven storing of the mixed material is sometimes necessary. This difficulty can be eliminated by the adoption of R.F., since a sufficient number of preheaters may be installed to ensure a steady supply of heated p.v.c. to the calender.

D. WARBURTON-BROWN.

Cheltenham.

Supports for Electrolytic Work

Sir,—With reference to the query of A.C.A. and Co., I would like to state that plastic sheaths for "jigs" (I assume that is what they mean) are not generally used on account of the often complicated shape of the jigs. Instead, it is usual to employ plastics in solution form, such as polyvinyl chloride in the correct solvent or plasticizer, a nitrocellulose lacquer or a rubber-based lacquer. The jigs are

either dipped or sprayed and the points of contact are then cleaned.

Several good stopping lacquers are already on the market, the type to be used depending upon the type of electrolyte in which it is to be used. Probably the best of these is one marketed by International Corrodeless, Ltd., Lockfield Avenue, Enfield, and known as "Polycote."

FRANK TAYLOR.

113, Amberley Road,
Bush Hill Park, Enfield.

[EDITOR'S NOTE: Whilst thanking our correspondent for the advice which he offers, we are inclined to think that the true point of the original inquiry has been misunderstood.]

Luminous Plastics

Sir,—Some time ago I saw an experimental sample of luminous plastic material. Since then I have seen samples of similar material in Sweden and in the U.S.A. It is possible that British manufacturers are now handling this product, but I am unable to obtain any reference.

C. H. JACKSON,
Chief Project Engineer.
British Overseas Airways Corporation.
20, Berkeley Square, W.1

[EDITOR'S NOTE: Luminous plastics were all the rage during the early part of the war, and were of considerable use on board ship, especially in the Navy. It has always been our opinion, however, that in peacetime luminous plastics would not be in sufficient demand to warrant continuous production.]

Fibres and Fabrics of P.V.C.

Sir,—We note the frequent mention in "Plastics" of the use of polyvinyl chloride for the production of fibres and fabrics. We should be glad to know what uses they are put to and the names of manufacturers of the fibre. J.H.T., LTD.

Manchester.

[EDITOR'S NOTE.—We do not know of any concern in this country making p.v.c. fibre or fabric. We should imagine there is too great a shortage of the raw material. We believe, however, it is being produced in the U.S.A., and we know it is that France is doing so in the latter country by a firm named Colcombet, who also make nylon and glass fabrics. The p.v.c. fabric can be used for normal clothing manufacture, but should be especially useful in chemical works for filtration of acid solutions. The quantities for the latter industry would, of course, not be very great.]

Plastic "Sequins"

Sir,—We are seeking a manufacturer able to produce sequins of the type of the sample enclosed. These particular sequins, however, are inflammable. We wish to have similar material that will satisfactorily resist heat and still retain decorative characteristics of the sample.

H. L. FISHMAN.

Camden Town, N.W.1.

[EDITOR'S NOTE: The samples are "sequins" with a metallic lustre, probably punched out of gelatine or similar organic films, since the material burns with the well-known "protein" odour and swells in water. It is not, however, inflammable, and we presume that the writer means that it softens and decomposes by heat. We fear that no plastic of such thickness could be made that will answer his purpose.]

Car Battery Containers

Sir,—We are anxious to be put in touch with manufacturers of plastic Monobloc motorcar battery containers, a sample of which we have recently seen here in Dublin. This sample was received from a trading firm in Wembley.

HARRY BRAINE AND SONS, LTD.
59b, Lower Dorset Street,
Dublin, C.14.

Heating for Injection Moulding

Sir,—Can you give me the name of the makers of the "Sundvic" heating element, as used on injection-moulding machines. I am also interested in construction details of the heated chamber, powder spreader, plunger, etc. It would be pleasing if you could devote some space to this subject. E. F. CLAPSON.

Lewisham, S.E.13.

[EDITOR'S NOTE.—We presume you refer to "Sunvic" energy regulators, as used for controlling the energy input of the heating elements on moulding machines. These regulators are made by Sunvic Controls, Ltd., Stanhope House, Kean Street, London, W.C.2.

Rubbers to Aid of Paints and Plastics

By W. H. STEVENS, A.R.C.S., F.R.I.C.

IN war as in peace natural rubber has the highest statistical bounce, and, true to its reputation, it continues to provide surprises. In the past, price fluctuations have been the most notable, but since price was controlled the supply position has been far from predictable. It is now expected that from a period of acute scarcity we are shortly to pass to one of ample supply. This being the case, it is of interest to review the present technical position of rubber derivatives, which have applications outside the rubber manufacturing industry and which may be able to fill some of the gaps in the present supply position of customary paint and plastic raw materials.

In addition, it may be useful to review the position of rubber derivatives as it was before the war, when many promising developments were abruptly stopped. During the war new products, especially synthetic derivatives, as also modifications of known products, were made, and these add considerably to the total possible applications.

Chlorinated and Cyclized Rubbers

The development of useful rubber derivatives is best recounted in an approximately chronological order. Chlorinated rubber was the first derivative to find application on an industrial scale, outside of vulcanization. It was originally manufactured in solution form under the name of Duroprene by Imperial Chemical Industries, Ltd. This product was offered for use as a corrosion-resisting paint, and found several applications, but suffered from a tendency to ropiness.

A similar product, but improved as regards reduced viscosity and easier handling, was developed by Detel Products, Ltd. (B.P. 305,968), and Detel paint finds wide use in corrosion-resisting applications, such as in chemical factories. There seems no reason why the use of this type of paint should not become much more general; prior to the war dry powdered chlorinated rubber was becoming a regular raw material of the paint manufacturer. Current use, and much development work, however, was impeded when the war caused unprecedented rubber shortage. This position now seems likely to be reversed, and with promise of ample natural rubber supplies the paint manufacturer may be wise to review the possibilities of relieving current shortages by the adoption of chlorinated rubber formulations. There do not seem to be any facts on record which would militate against a much more general use of chlorinated rubber.

Solid chlorinated rubbers are manufactured by Imperial Chemical Industries, Ltd., and by Hercules Powder Co., Marbon Corporation, and Goodyear Tire and Rubber Co., in the United States, the respective names for the product being Alloprene, Parlon, Marbon and Pliochlor. Before the war, German material was also available under the names of Tornesit and Tegofan.

Cyclized or "cyclo" rubber is another well-known derivative of natural rubber having various applications. The material is prepared by the action of isomerizing agents on raw rubber; the agent originally used was sulphuric acid (Harries, Kirchhof, H. L. Fisher), with the intention of producing artificial gutta percha and balata, but chlorostannic acid, benzene sulphonic acid, and phenol sulphonic acid (B.P. 553,715) are now mostly used. Commercial products are Marbon B, Plioform, Pliolite and Isolac, as made in the United States. They are

used in paints especially for alkali resistance. The attachment of rubber to metal by means of cyclized rubber cements (Vulcalock) is also well known. The application to paints and coatings for external use is limited by the incomplete resistance to light ageing, and in this respect chlorinated rubber is superior. Both types of coatings have excellent resistance to alkaline or acidic conditions and are widely used for special paints for chemical works, concrete surfaces, swimming baths, etc.

For semi-elastic, flexible or tough products such as paper coatings, hot-melt compositions, balata substitutes for use on golf balls and submarine cables and the like, cyclo rubber is also suitable. It seems probable that moulding possibilities have not yet been fully explored, either for chlorinated or cyclized rubbers. Preliminary work in this field resulted in the development of expanded chlorinated rubber (B.P. 424,561), and a first report on moulding the material (Schidrowitz, Bull. Rubber Growers' Assoc., 1934, **16**, 668).

Another product of a somewhat similar character to the foregoing is rubber hydrochloride This material, which is made by treating raw rubber with hydrochloric-acid gas, contains about 35 per cent. of chlorine in contrast to the 65 per cent. in chlorinated rubber. It is, however, equally saturated and inert. Its value lies in its physical properties, which render it particularly suitable for the manufacture of thin films. These films are impervious to moisture and vapours, flexible and heat sealable, and have been used to the limit of availability for tropical packaging.

The best-known rubber hydrochloride is the Pliofilm of Goodyear Tyre and Rubber Co., used primarily as a packaging tissue. A similar product is made in this country by Paraplastics, Ltd., using the Frenkel film-casting machine.

Treatment of rubber by oxygen in the presence of catalysts has been shown to give useful results, both for certain classes of paints and resins.

The chemical combination of a very small amount of oxygen results in a considerable degree of depolymerization, presumably through chain rupture, with consequent changes in physical properties. Thus, normally viscous rubber solutions are adequately reduced in viscosity to enable them to be used in paints. The improvements obtained in paints by this addition are mainly in the direction of increased flow and are most valuable in flat paints. To-day the mere physical augmentation of the vehicle may be an additional advantage. (See "Rubber in Paints and Varnishes," published by Rubber Growers' Association.)

If oxidation is carried far enough to result in the addition of one molecule of oxygen to each two isoprene units, a resin is obtained; this resin is termed Rubbone. It can be used as part of the film former and as flatting agent in paints, and has also been found useful as a binding resin. Thus, it can replace shellac for bonding mica for electrical applications, with the advantage of improved heat resistance. (Trans. India Rubber Inst., 1935, **II**, 182; "Elec. Review," July 30, 1937.)

Probably neither oxidized nor cyclized rubbers are suitable for external-grade paints, as they tend to embrittle by light ageing. For this major application, it seems that chlorinated rubber merits further consideration. Also, the possibility of using antioxidants for promoting the life of rubber derivative coatings seems not yet to have been examined. The process of building chain molecules and then "short-stopping" the chains at the required length is common practice in "tailormaking" synthetic rubbers and resins.

Low-polymer "Rubbers"

Along with the development of synthetic rubbers there has arisen a class of resins which are mostly low-polymer styrenes, or straight-chain hydrocarbon polymers or co-polymers. Most of the developments have taken place in the United States, where raw materials are available, but as petroleum development

and usage progresses in Britain parallel productions may be expected.

As the urge to produce synthetic rubbers becomes less and less, these alternative products may receive more attention, both as a means of employing the available intermediates and for the provision of badly needed film-forming materials. Also, in reviewing the value of development of synthetic products in this country, it is not sufficient to examine only the home market; export possibilities are great, particularly if to post-war shortages are added the future demands for quality products. After all, linseed-oil finishes are relatively impermanent.

Synthetic hydrocarbon resins, such as Marbon S, Pliolite SS, the Stanco S.40 to S.60 range and the Polymeths, are suggested for use in the developments under review. They are film formers, non-extractable plasticizers, toughenes or mere make weights (" organic fillers "), as desired.

Films having good resistance to sunlight are reported as being obtainable from combinations of synthetic rubbers, particularly butadiene - acrylonitrile (GR-A) and neoprene (GR-M) or Thiokol (GR-P). (Garvey and Emmett, " Ind. Eng. Chem.," 1944, **36,** 209.)

Another possibility is the translation of the flexible wax type of coating normally applied as a hot melt, to a solvent type of composition for wider use. These products have high moisture resistance, and might weather well if satisfactory adhesion can be obtained. The simplest and cheapest type consists of paraffin wax emulsified in rubber latex, but synthetic alternatives are also available. (Dispersion in water provides an economic means of application whenever it can be used.) Micro-crystalline waxes require a minimum of film former, such as ethyl cellulose or polyisobutene, to produce continuous films; and production of these waxes in this country has commenced.

The combination of butadiene-acrylonitrile copolymers (GR-A) with vinyl resins is well known. The synthetic rubber, even without vulcanization, acts as a non-leachable, non-volatile plasticizer. Improved sheetings and extrusions can be made. The use of GR-A in phenolic moulding materials may be less well known, but is of interest because of the improvement in impact strength, as well as for the extension of volume.

In all directions the shortage of vinyl resins is a major problem. Why, then, substitute these rarities for good vulcanized natural rubber, particularly when " plastic " waterproofs lend themselves for the spoliation of the good name of the industry? With the modern developments in rubber chemicals, proofings of excellent ageing properties could be made.

Floor Coverings

Another field showing great possibilities of development by substituting rubber for other materials is that of floor coverings. Linseed oil at £135 per ton and in short supply, and p.v.c. at present availabilities, are entirely unattractive to the flooring manufacturer. On the other hand, rubber tiling, rubber flooring and " rubber lino " are distinct products of limited current availability, but of considerable promise for development in big quantities. In particular, a re-examination of the possibilities of " rubber lino," i.e., rubber flooring with organic fillers, seems warranted.

Finally, renewed supplies of latex will promote the use of cement-latex types of jointless floors. The range of this class of product has been greatly extended by war-time developments and substitutions, but the genuine latex floor probably remains the first choice for locations where warm sub-floors are required on concrete or similar bases, to say nothing of wider use as ships' decking and for the smoothing of hulls.

In the future, manufacturers in the fields discussed will have a much wider choice of raw materials, and natural and synthetic products will have to be considered jointly, careful selection being made according to circumstances. For the present, adaptation and substitution will continue to be necessary until the post-war leeway has been overtaken.

P.V.C. at a German Explosives Plant

AN interesting method of imparting a polished finish to sheets of p.v.c., cellulose acetate and nitrocellulose is revealed in the reports of the Combined Intelligence Objective Sub-Committee (C.I.O.S. File No. XXIV—3) relating to investigations at the plant of Dynamit A.G., at Troisdorf. The presses operated under a pressure of 120 kg. per sq. cm., with the plastics sandwiched between nickel-plated steel sheets measuring approximately 5 ft. by 2 ft. The temperature of pressing was 120 degrees C. to 140 degrees C. for p.v.c., the pressure being maintained on cooling in order to impart a glossy finish to the thermoplastic material. The steel sheets were electro-plated whenever the surface showed serious wear or scratches. The process, as carried on, was intermittent but a continuous method of conducting this operation had been in the minds of those concerned. Some of these polished sheets had been used for blast-proof windows to buildings.

This report also describes other uses of plastics which might warrant further investigation. For instance, the initiator sections of the works at Troisdorf, where lead azide and styphnate were mixed, possessed a floor covering of conducting material, although the view was expressed that the flooring did not particularly decrease an individual's electrostatic charge. There was no record of the formulation of this material, but it consisted essentially of p.v.c. pigmented with carbon black and plasticized with tricresyl phosphate.

In materials involving p.v.c., the tricresyl phosphate was usually in amounts of from 30 to 60 per cent. by weight. Tributyl phosphate was sometimes used as also substitute plasticizers of poor quality, but tricresyl phosphate was stated to be undoubtedly the best material.

In the electric igniter section there was a machine capable of sheathing 200 metres of iron wire per minute with p.v.c. covering applied under pressure at a temperature of 80 degrees C. These insulated wires were employed in the preparation of electric detonators.

The mouth closure of electric detonators containing delay systems from ½ to 10 seconds was effected by crimping on a piece of polyvinyl tube fitting snugly into the mouth of the detonator and carrying the insulated conducting wires. An auxiliary crimping operation, ½ in. from the mouth of the detonator, prevented this waterproofing plastic tube from being inserted too far. A lead seal has previously been employed.

"Zapon" nitrocellulose lacquer was generally employed throughout the works as vehicle for the suspension of the pyrotechnic mixes employed for the "dipping" of electric igniter wires.

Detonating fuse was manufactured by the introduction of 9 gm. per metre of the appropriate powder into a Cellophane tube, which was subsequently reinforced with two windings of cotton and covered with a final sheathing of p.v.c. Match igniter heads of the electrical pattern, made from a comb of chrome steel, were observed to have a small slab of p.v.c. (about ¼ in. square) acting as an insulating bridge between the metal poles.

SWEDISH PLASTICS FEDERATION

At the invitation of the Swedish Plastics Federation, Mr. C. H. Glassey and Mr. C. S. Dingley, of British Industrial Plastics, Ltd., attended their conference in Stockholm on December 11 and 12. Mr. Glassey, as chairman of the Export Group of the Plastics Industry, gave an address on exports, more particularly as they affected the Swedish plastics industry; at a subsequent session he spoke on education in the plastics industry, from notes supplied by Mr. Kenneth M. Chance, chairman of the Joint Executive Committee for Education and Training. "Certification Marks for Plastics" was the subject of Mr. Dingley's address; he referred to what was being done, not only in Great Britain, but also in France and America. Mr. Dingley is chairman of the Moulders' Group of the British Plastics Federation.

Plastics for Buses

VISIONS of the future when bus bodies might be designed for wider use of plastics, and possibly the metal structure itself would be bonded together by synthetic resin cements in place of welding or riveting, were given by Mr. C. C. Bailey, A.M.I.A.E., bodyworks manager of Leyland Motors, Ltd., when addressing the Leyland Motors Engineering Society. His paper, "Plastics and Its Uses in Passenger Service Vehicles," had been prepared jointly with Mr. H. C. Gillvray, chief body designer of Leyland Motors.

"If one remembers that plastics generally are about five times lighter than steel, and thus lighter than aluminium," said Mr. Bailey, "it will be obvious that such materials must have an interesting future in the hands of competent designers. It must, however, be borne in mind that plastics can only be used in place of metals when the strength, weight and section modulus are each in the favour of the contemplated plastic."

The more ordinary but never-to-be-forgotten phenol-bonded plywood materials had recently returned to the limelight. The interesting procedure of tailoring the plies to suit varying shapes, and bonding these with resin glues by the rubber-bag system in an autoclave, brought them to a practical process, somewhat expensive at the moment, where one could use a very strong and tough fibrous material, such as timber, in any desired shape without loss of strength. The reason why phenol-bonded ply was not used extensively for structural parts on passenger service vehicles was because of the vast difference in design between, say, aeroplane and bus. On passenger service vehicles it was necessary to repair a body as easily and as quickly as possible when minor accidents were frequent. Stresses set up in the structure of a bus when it travelled over uneven roads, moreover, were uncushioned and therefore severe. "It may be possible in the future," said Mr. Bailey, "to use plastics and plywood to useful advantage provided that suitable methods for joining one section to another are found."

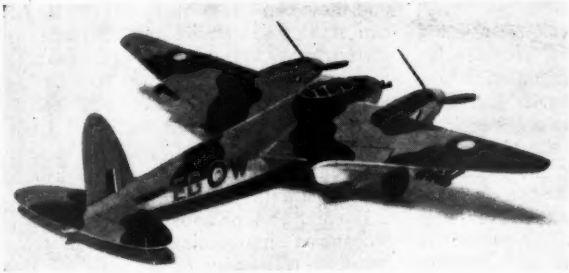
On the subject of glues, Mr. Bailey said that it was now possible to bond with amazing success two metal surfaces, such as steel or aluminium-base alloy, where tensile tests would disclose the fact that the parent metal would fail before the bond.

Having described some of the outstanding developments in plastics, Mr. Bailey told of applications on passenger service vehicles, and indicated where such materials could possibly make further developments for the future. The variety of colours that could be obtained in plastics was now almost unlimited; as the colours were pigmented into the base material it could be made most durable. Coach bodies were already showing coloured pressed lamp covers; many of these were made from the synthetic paints used for interior and exterior finishes of the modern body. These paints were capable of being dried very rapidly by infra-red ray or similar processes, due to the fact that the resins were polymerized by application of heat.

There were also other articles made from plastics which were in everyday use on buses. New phenol paints were being developed for resisting cigarette stubbing, as also to resist wear over a long period. Those plastics had many advantages over the other materials bodybuilders had been accustomed to use, for they were almost impervious to water and resisted mechanical damage to a notable extent. If plastics could be used instead of steel or aluminium, there was added advantage, for all knew the drawbacks of the rusting steel and the corrosion of aluminium unless properly treated.

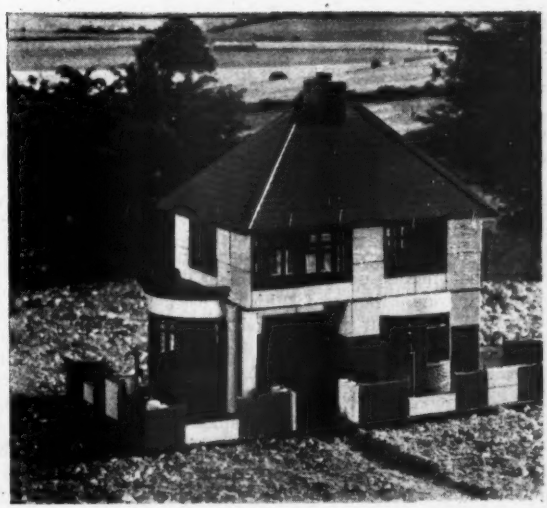
Concluding, Mr. Bailey said: "With the vast range of the different developments of plastic materials, the extreme limit of possible application would embrace practically everything with the exception of the main load-carrying structure."

Plastics Make Realistic Toys



(Above) Model of Spitfire XII. (Left) Mosquito VI. with rocket projectiles under the wings.

International Model Aircraft Ltd., of Merton, London, S.W.19, produce the parts from which model aircraft of all types are constructed as a hobby. The above illustrations are from finished models made with Penguin aircraft kits (Series I), which are true in minute details upon a scale of 1 in. to 6 ft. All parts are finished mouldings, which require only the removal of a slight flash, with pocket knife or glasspaper, before final assembly. The kits feature fully-retractable undercarriages, transparent turrets and cabins, and detailed radial motors where required.



This house, with all-plastic sections moulded in Beetle, is one of a range of buildings, from garages to castle, which can be built with Bayko patented building sets. The sets are graded to allow increasing scope for constructional initiative by any precocious youthful architect. The white and red brick sections, green windows and doors (the latter measuring 1¾ in. × ¾ in.) are held in position by metal rods which fit into internal grooves. Production by the Plimpton Engineering Co., of Liverpool.

Halogenated Polythenes

By E. E. HALLS

IT will be generally acknowledged that polythene is one of the most amazing plastics of recent years. Its development and commercial production, its exploitation and adaptation to immediate needs, and the rendering of it available in a big way during the war years, are achievements that warrant recognition. The manipulability of the material, including ease of extruding into tubes and sleevings, coverings for conductors, sheet and strip, and moulding into shapes, the possibility of spraying through a flame gun, the ease of heat sealing, etc., account in large measure for its success; its properties contributed the remaining portion. Extreme chemical resistance, inertness, stability, moisture impermeability, excellent electrical properties, including power loss at high frequencies and extreme humidity, are outstanding features.

Naturally, no material can ever fulfil the criteria for the ideal, and polythene has its shortcomings. It possesses a relatively high coefficient of contraction, that under some circumstances promotes voids, and in others causes shrinkage away from copper conductors or metal inserts. For this reason it is not generally possible to make a moisture-proof seal at leading-out tags, unless special steps are taken. Again, grading is not simple because the polymer exists in a wide range of molecular weights, all with approximately the same melting point but having different viscosities near and above that melting point. The higher the molecular weight the greater this viscosity value. A particular grade based on viscosity may be material of closely the same molecular weight or an average of widely differing molecular weights. This may or may not be of material importance, dependent upon the specific application.

Next, the material is a crystalline one, subject to strain and directional properties dependent upon the strain to which subjected. This can cause physical and mechanical differences in strip material, and these can cause many difficulties. It can also cause deterioration in electrical dielectrics by creating paths of weakness through which breakdown occurs at lower voltages than normally anticipated. In this same connection flexibility is not all that can be desired, and this in turn may enhance the importance of avoidance of strain.

Finally, and perhaps the most widely recognized shortcoming, is that of temperature resistance, or at least of the upper limit of resistance. A maximum of 60 degrees C. is generally regarded as a safe working temperature; short periods at 70 or even 80 degrees C. are satisfactory. Failure is usually abrupt, due to flow, this occurring between 90 and 120 degrees C., according to temperature and pressure conditions. It is in this direction particularly that improvement is sought and research and development work is watched with eager interest.

Improved Thermal Resistance

An improvement in thermal resistance is expected from halogenation. Chlorine is recognized as the usual halogen in plastic materials. Electrical engineers, of course, are always wary of this element even in so-called stable compounds, because of the possibility of traces of free hydrochloric acid, or of its development under conditions of exposure to heat, light and/or humidity. In many applications, this would be of little or no consequence; in others it has to be given serious attention.

Halogenation can be achieved by halogenating the hydrocarbons and then polymerizing the halide so obtained, or the polythene can be halogenated directly. It does not follow that the same com-

pound, or series of compounds, can be produced by the two methods. Again, compounds having the same halogen content when formed in the two ways will not necessarily possess identical properties, physically, electrically or mechanically.

Fluorinated and chlorinated polythenes have been produced and commercialized, the first in America and the second in this country.

Fluorinated polythene is interesting in many ways. It represents the first major use of a halogen other than chlorine in commercial plastic materials. The plastic itself possesses some extraordinary properties, and its production in itself is a feat of chemical engineering. Polyfluorethylene is made by polymerizing tetrafluorethylene at moderate temperature and pressure. The fluorethylene is made by direct reaction between fluorine and ethylene. The monomer is a gas; the polymer, a white solid.

Polymerization of Tetrafluorethylene

The production of the monomer entails all the physical and chemical difficulties, as well as the health hazards, associated with the highly reactive halogen, fluorine, as well as those concerned with hydrogen fluoride that is formed in the reaction. The polymerization additionally involves the dangers normally associated with high-pressure plants. Nevertheless, complete success has been achieved and polyfluorethylene is available in America in quite large quantities, although the price at present is very high.

British patents covering the American product have now appeared, and as the material is certain to have a large field in the future on account of its unique properties, these patents have been abstracted in the present article.

Brit. Pat. 572,265 (1945) of E. I. Du Pont de Nemours covers the polymerization of tetrafluorethylene by contact with an aqueous solution of an inorganic peroxygen compound at elevated pressure. Operating temperatures claimed are those within the range of 20 to 100 degrees C. and pressures from 20 to 200 atm. Alkalinity of the aqueous solution, and ammonium persulphate or an alkali metal persulphate as the peroxygen compound, are also included.

Regarding details of interest from the patent, prior knowledge is indicated for the polymerization of tetrafluorethylene by standing at room temperatures under superatmospheric pressures for a considerable period of time, and for the fact that the process could be accelerated by the presence of certain catalysts, such as silver nitrate in methanol. The best yield disclosed was 29 per cent., based on the monomer in a period of three days at 25 degrees C.

Optimum Conditions for Polymerization

By the invention of polymerization at an elevated pressure in the presence of an inorganic oxygen compound in aqueous solution, high yields in a short time are claimed, giving a rapid and economic method of production, capable of adaptation to continuous operation.

It is claimed that the new method of processing can be effected over a wide range of temperatures, as low as 0 degrees C. or as high as 200 degrees C., but that best results are obtained within the range from 20 to 100 degrees C. In this band of temperature, polymerization proceeds smoothly and rapidly. Pressures as high as 1,000 atm. are mentioned, with the proviso that adequate means of dissipating the heat of polymerization must be incorporated. The preferred pressure range is given as 20 to 200 atm., in which high yields of polymer are possible in one hour or less. Lower pressures down to 1 atm. are quite practicable for achieving complete polymerization, with considerably longer times, several hours being required. Again, it is preferable, but not essential, to maintain a pH value of the reaction mixture greater than 7.0, because higher yields of polymer are secured.

The inorganic peroxygen compounds referred to consist of salts of the true peroxygen acids, such as persulphates, perphosphates, percarbonates and perborates, as well as true inorganic peroxides, the latter being the substitution

products derived from hydrogen peroxide, e.g., barium peroxide or zinc peroxide. The water soluble salts of the peroxygen acids are such as the sodium, potassium, calcium, barium and ammonium salts of persulphuric and perphosphoric acids. These may be prepared by electrolytic oxidation of salts of the corresponding oxy-acids. The alkali metal and ammonium persulphates are said to be highly effective and readily available and inexpensive, and they are therefore given preference.

Modifying agents, such as sodium bisulphite and sodium hydrosulphite, are mentioned, and it is stated that they can be included to increase the effectiveness of the catalyst. Regarding quantity of catalyst, as little as 0.003 molecules per molecule of tetrafluorethylene can be used, but from 0.01 to 1.0 molecules is preferred.

Reaction Procedure

A procedure for carrying out the reaction is given. A pressure-reaction vessel is charged with the aqueous solution of alkali metal or ammonium persulphate, concentration of the order of 0.2 per cent., together with from 0.5 to 10 per cent. of an alkaline buffer, such as borax. The reaction vessel is then evacuated to remove the bulk of the atmospheric oxygen. Next, it is charged with monomeric tetrafluorethylene as a liquid or gas under pressure, so that the pressure within the vessel is between 20 and 200 atm. The reaction vessel is then agitated and heated, for example, to 80 degrees C. The progress of polymerization is indicated by progressive decrease in pressure, and it proceeds to completion in less than one hour, even with as little catalyst as 0.003 mols. per mol. of tetrafluorethylene.

The process can be modified by maintaining at constant pressure by continuing to feed monomeric tetrafluorethylene to the reaction vessel; polymerization then continues smoothly and rapidly until the catalyst is exhausted. Further, it can be rendered continuous by continuously feeding both monomeric tetrafluorethylene and a solution of catalyst to the reaction vessel, and by providing means for withdrawing aqueous liquor and granular solid through a pressure-reducing device.

Other interesting modifications to the process procedure are noted. One of these allows an organic solvent to be present in the reaction chamber, e.g., an alcohol, acid, ether, amine, hydrocarbon, ketone, ester or nitrile. In this way the reaction may be carried out in a mixture of water and solvent of the aforementioned type, and the solvent may or may not be miscible with the water. Suitable solvents cited include ethanol, acetic acid, dioxane, methylamine, iso-octane, cyclohexane, ethyl propionate and acetonitrile. The ratio of water to solvent is only critical in so far as sufficient water must be present to dissolve a substantial amount of catalyst.

Another modification permits the inclusion of dispersing agents, particularly in conjunction with water-immiscible solvents, the object of these additions being to facilitate the production of a finely divided material.

Yet another procedure enables finely divided solids to be included in the polymerization mixture, these solids thus conveniently being dispersed in the polymerized product as filler materials. Pigments, such as titanium oxide and carbon black, and metals, such as copper, are quoted as possible examples.

Plant Precautions

Generally speaking, any apparatus that will safely withstand the operating pressure can be used for the process. Corrosion-resistant materials for the reaction vessel, as linings for it, are, however, preferred in order to minimize the possibility of introducing metallic impurities into the product. The polytetrafluorethylene is insoluble in all known solvents, and this makes it exceedingly difficult to remove any such impurities. At the high reaction temperature discoloration of the product is caused by metallic salts, especially those of iron.

Examples of the process are given below, quantities being parts by weight:—

(1) A stainless-steel pressure vessel was charged with a solution comprising 0.2 parts of potassium persulphate and 0.5 parts of borax in 100 parts of water, this occupying 25 per cent. of the volume of the vessel. The vessel was then closed, evacuated and charged under pressure with 30 parts of tetrafluorethylene, the pressure then being about 25 atm. The vessel was agitated and heated to 80 degrees C. for one hour. Upon cooling to room temperature, there was no residual pressure. The yield was 26 parts of white granular polytetrafluorethylene (87 per cent.).

(2) A silver-lined vessel was charged with a solution containing 0.2 parts of ammonium persulphate and 1.5 parts of borax in 100 parts of water, this charge occupying 25 per cent. of the volume of the reaction chamber. The vessel was closed and evacuated to remove atmospheric oxygen and then charged with 30 parts of monomeric tetrafluorethylene under pressure, the latter being approximately 25 atm. The vessel was then agitated and heated to 80 degrees C. for one hour. It was then cooled. There was no residual pressure and the pH value of the final mixture was greater than 7.0. The yield was 30 parts of white, granular polytetrafluorethylene (100 per cent.).

This product was suitable for pressing films by maintaining it at about 400 degrees C. under a pressure of 1,000 lb./sq. in. for 5 minutes, and then quenching. The films are stated to have exhibited a tensile strength of 2,500 lb./sq. in., based on the original dimensions, and strips of film a reduction by cold drawing of 420 per cent.

(3) A sterling silver-lined vessel was charged with 100 parts of water, 0.2 parts of ammonium persulphate, 2 parts of borax, and 200 parts of tetrafluorethylene under pressure. The pressure was about 150 atm. The vessel was then agitated and heated to 50 degrees C. for six hours. The yield was 194 parts of polytetrafluorethylene in the form of tough, massive pieces (97 per cent.). The pH value of the aqueous phase of the reaction mixture was 8.0.

(4) A silver-lined pressure vessel was charged with 100 parts of water, 0.2 parts of ammonium persulphate, and 25 parts of tetrafluorethylene under pressure. The pressure inside the reaction chamber was then approximately 20 atm. The vessel was then agitated and heated at 80 degrees C. for six hours. Only four parts of white granular polytetrafluorethylene was obtained (16 per cent.). The aqueous phase of the reaction mixture was acidic, i.e., pH lower than 7.0.

Properties and Applications of Polymer

The polymer obtained by the methods of this invention is a white, granular solid. It is insoluble in all solvents and impervious to the attack of acids and alkalis, including sulphuric, nitric, hydrochloric and hydrofluoric acids, and 40 per cent. aqueous caustic alkali. It is said to be thermostable to at least 500 degrees C. and can be pressed and moulded at temperatures above 300 degrees C. Density is approximately 2.2, and refractive index approximately 1.3 (sodium D line).

Applications mentioned include many for industry based upon the chemical inertness of the material. It can be employed as a corrosion resistant liner to metal equipment or plant, especially for the acids and alkalis mentioned above at elevated temperatures. It can be made into flexible tubing, for example, for chemical plant, well suited for carrying corrosive liquids and gases. Gaskets and valve packings can be made from the material, and serve where other materials fail to resist corrosion and/or process temperature. Pump diaphragms made from the polymer serve for pumping liquids that have corrosive or solvent properties that preclude the use of other diaphragm materials.

Polyfluorethylene bearings are said to be useful in certain instances, and container closures such as bottle cap liners are invaluable, because of good sealing qualities and inertness to corrosive attack.

(To be continued)

Book Reviews

"Plastics Applied." Edited by V. E. Yarsley; 2nd edit.; pp. 528. National Trade Press. 42s.

The first edition of this book appeared in 1945. It is essentially a general survey, incorporating patent and technical literature and collected data of interest to users of plastics in all branches of industry. In all, there are 26 contributors. Section 1 gives an introductory review of the industry, with separate chapters devoted to a discussion of design and colour. Section 2 covers the use of plastics in particular industries, some of which are not widely known but none the less interesting and with a useful future. Questions relating to health hazards and safety precautions in the plastics industry are discussed in Section 3. The collected data (Section 4), which extends to about 100 pages, includes numerous physical and chemical tables, a schedule of British raw materials, and a glossary of trade names. The book is illustrated throughout and, additionally, has eight colour plates. It is no part of the book to treat of the manufacture of plastics, nor of working up into the form in which materials come to the user. The contributors are introduced in short biographical notes.

"Plastics Mould Engineering," by J. H. Du Bois and W. J. Pribble; pp. 494. Technical Press, Ltd. 45s.

This most comprehensive book on toolmaking should be read by all apprentices, draughtsmen, and others interested in designing and producing tools. It emphasizes the need for good steels and outlines the basic principles to be observed in the design of the various types of tools for compression, injection and extrusion presses, dealing also very comprehensively with the questions of tolerances and shrinkage allowances.

Certain of the more advanced points are only briefly dealt with. For example, "It is possible for the alert engineer to design . . . fixtures that will permit the manufacture of certain types of work at low cost." We should have enjoyed far more details of these devices, together with more details on preform moulds. We are surprised to see the statement that acrylics are generally injection moulded, and that the author treats clamping pressures in transfer tools as though the theory of hydraulics applied exactly. The photographs are excellent and the type very clear, although the prints are rather overcrowded, and with insufficient explanations in parts.

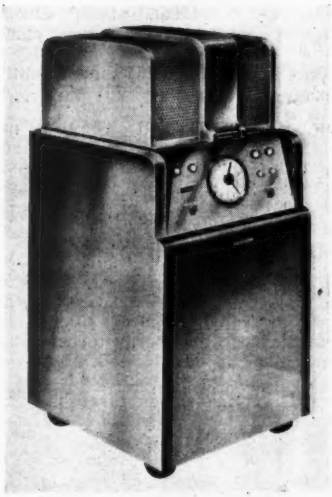
This book, however, comprises a summary of the basic facts of plastic mould building, and provides a wealth of information for the serious student of tool design which can be an excellent foundation for later experience. The whole production of plastic mouldings depends on the previous production of tools; a product can only be as good as the tool which makes it.

"Plastics in the World of To-morrow," by Capt. Burr W. Leyson; pp. 95. Paul Elek Publishers, Ltd., 10s. 6d.

This book has been written for the general public interested in the future of plastics, and for those among them who intend to seek a career in the plastics industry. The characteristics and industrial uses of the principal plastics are given in 17 short "chapters," some of which are so short that they do not fill one page. Additionally, there are sections devoted to plastics in the aircraft industry and fabrication (compression, injection and extrusion moulding). Numerous illustrations are included, a large number of which are from American sources; considered as a whole, they are not very enlightening. The text also leaves much to be desired in the matter of completeness, even for the intended scope of the book. In the bibliography we notice an author's pseudonym given as the title of the book!

PRODUCTION NEWS

Raw Materials, New Plant, Works Organization, Control Apparatus, Research, Personal and Trade Notes



NEW RADIO FREQUENCY PRE-HEATER

WITHIN the past two or three years there has been a considerable amount of investigation into the use of radio frequency preheating for moulding materials. It is now well established that this form of preheating allows very substantial advantages to be gained by the moulder.

With early difficulties overcome, the plastics moulding industry is already using R.F. heating equipment as a means of effecting increased production. By means of radio frequency the moulding powder can be uniformly heated, very rapidly, to about 100 degrees C., at which stage it is assuming a truly plastic condition. Because of this, the pressure may be applied to the mould more rapidly. This, in conjunction with the rapidity of the pre-heating, makes for reductions in production times of as much as 50 per cent., and also enhances the mechanical and electrical quality of the mouldings concerned.

To equipment already on the market for the R.F. pre-heating of plastics materials is now added the Deltron pre-heater D10. This pre-heater, designed as a result of considerable experience in radio-frequency heating problems, is manufactured by Delapena and Son, Ltd., of Cheltenham. The equipment has a heating capacity of 2 lb. of moulding powder through 100 degrees C. per minute, and incorporates features which have been found desirable in the plastics industry. These features include press-button control, automatic lid-opening at the end of the heating cycle, easy access to heating electrodes, and a built-in hour meter which enables an accurate check of valve life to be taken. The floor area needed for installation is 25½ ins. by 24 ins.

The circuit is so designed that any variation in the electrical characteristics during heating, due to different sizes of work, does not affect the performance of the oscillator. The circuit will operate efficiently with an air gap between the top of the preforms and the upper electrode, which gives even heating with pellets of unequal size. Another important feature is that the circuit is so designed that no tuning is necessary.

Protective relays are fitted in both grid and anode circuits, and a thermal delay switch is fitted to prevent full anode voltage being applied to the valves before the filaments are warmed up, thus increasing valve life.

The electrode assembly is so designed that adjustment of the upper electrode to vary the spacing may be made externally with the lid closed and while the set is operating. This simplifies the setting operation and reduces setting time to a minimum. Adjustment, moreover, is made in conjunction with the overload warning light, which indicates when the air gap is too small. The standard electrode size is 16 ins. by 10 ins.; smaller electrodes may be fitted as desired.

Electrical and mechanical interlocking is arranged so that the unit cannot be switched on with the lid in the open position. The equipment is fully screened in accordance with G.P.O. requirements to prevent radiation and radio interference. An automatic resetting industrial process timer is also fitted; this is graduated in seconds to control heating times from 0 to 5 minutes, and may be switched out when not required.

MONSANTO CHEMICALS, LTD.—Following the recent appointment of Mr. John V. Head as assistant purchasing manager, and of Mr. W. Morgan Thompson as home sales manager, Monsanto Chemicals, Ltd., now announce the reorganization of their Home Sales Department. Mr. Donald C. M. Salt, who has been with the company for nearly 12 years, is now manager of the Heavy Chemical Department, a position relinquished by Mr. Head. Mr. Salt will assume responsibility for the sale of phenol, cresols and similar products. The Fine Chemical Department will be under the management of Mr. J. S. M. Dashwood, B.Sc., A.R.I.C. Customer contact, through area representation, will continue to be the responsibility of Mr. Morgan Thompson.

Mr. Robert Emrys Williams, a member of Monsanto's Ruabon staff, has just received the George Medal for the rescue of men from burning aircraft on three occasions while serving with the R.A.F.

P. B. COW (STREATHAM), LTD., have pleasure in informing the trade that they have appointed Dr. George Blaine, M.D., as their consultant. Dr. Blaine will advise P. B. Cow (Streatham), Ltd., and associated (or group of) companies on the medical and biological characteristics of various thermoplastics and rubber compounds that are incorporated in their products now and in the future.

E. H. JONES (MACHINE TOOLS), LTD., of Edgware Road, The Hyde, London, N.W.9, have now opened an office and stores devoted exclusively to machine tool equipment, under the control of Mr. S. Rowden. They can now offer a comprehensive automatic and capstan tooling equipment service, and have available for early delivery the new Offen boring tools and ground and cut thread taps for Thief tapping machines.

CELLON, LTD.—Mr. H. Bayley, manager of the Building and Decorating Division for a period of almost 15 years, died on December 31, after a long illness.

BEETLE BOND, LTD., of 1, Argyll Street, London, W.1, have sent us a copy of the export edition of their booklet on "Beetle Cement W2 and Hardeners" as used for the bonding of wood in the manufacture of plywood, and in the aircraft, boatbuilding and furniture industries. Hot Hardener 18 is a new powder hardener for use with Beetle Cement W2, which needs a minimum pressing time of five minutes at 90 degrees C., or only three minutes at 100 degrees C., adding one minute for each mm. thickness of wood between the source of heat and the innermost glue line.

O. AND M. KLEEMANN, LTD., report a net trading profit to August 31 of £264,619 (£109,248), which with rents and interest £1,276 (£906), makes £265,895 (£110,154). Sales for the first three months of the current year are considerably in excess of the corresponding three months of the past year.

DR. B. S. GIDVANI, who was until recently director, London Shellac Research Bureau, has now returned from an extensive tour of India and Europe. He is setting up a consulting practice on plastics and allied products at 25, Cheyne Place, London, S.W.3 (Flaxman 9366).

PLYWOOD BONDING.—Registered trade marks of British Tego Gluefilm, Ltd. (Tego Bonded), and Beetle Bond, Ltd. (Beetle Bonded), are shortly to be stamped on certain grades of plywood. Neither of these companies makes or intends to make plywood, but manufacturers of high-grade plywood will stamp their products with one of these marks when the plywood has been bonded with Tego Resinfilm or Beetle Cement.

DR. C. F. BAREFORD, M.Sc., Ph.D., has been appointed manager and head of the new Mullard Electronics Research Laboratory at Cross Oak Lane, Salfords, near Horley, Surrey. He has come to the Mullard Radio Valve Co., Ltd., direct from the Admiralty, and will be closely connected with the development of electronics as applied to industry.

WM. GARDNER AND SONS (GLOUCESTER), LTD., regret to announce the death of Mr. Frank C. Gardner, their chairman of directors, after a brief illness. The late Mr. Gardner had been chairman of this company since 1940.

L. KEIZER AND CO., LTD., plywood importers, Liverpool, regret to announce the death of Mr. Joseph Sellers Berry after a comparatively short illness.

MR. T. E. BARSTOW, of Punfield and Barstow (Mouldings), Ltd., died in a nursing home in Brighton in the early hours of December 23. The late Mr. Barstow was one of the oldest members of the plastics industry, having been associated with it since 1898.

New Productions from the Moulding Shops

Plastics Lavatory Pan

Mr. F. S. Saunders, superintendent of the Engineering Experimental Factory of British Overseas Airways Corporation, sends us the accompanying photograph of a plastic lavatory pan developed and manufactured under the experimental resources of his company. It is constructed entirely of "Perspex." Our

first reaction is to congratulate B.O.A.C. on a very excellent piece of fabrication mainly from the sheet. It is the largest complicated structure from "Perspex" we have yet seen. Doubtless the material has been chosen for its lightness (a factor so important in air transport), its hygienic properties and its strength even at low temperatures.

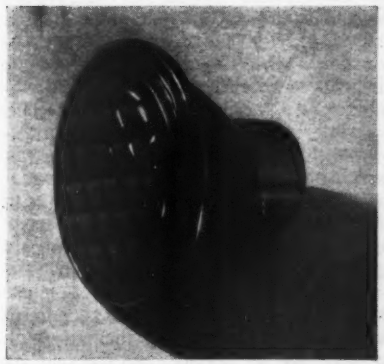
Jug for Handling Acids

A new pouring jug for use in laboratories, process rooms and wherever acids and organic solvents are used, has been produced by United Ebonite and Lorival, Ltd. It is cast in Lorival "A," a pale yellow phenolic resin, is light in weight, free from crevices, and impervious to most of the mineral acids and many organic solvents. It can be used for acids even at temperatures up to 100 degrees C. This Lorival jug is in every respect a worthy successor to the Lorival bucket, which has already proved itself invaluable in the handling of chemicals. Its capacity is two pints, and it is graduated

internally by rings indicating half-pint levels. Made of plastics, such a jug has a valuable feature in its freedom from causing sparks.

Cellulose Acetate Pressing

D. R. Aldridge and Co., 133, High Street, Bromley, Kent, inform us that its moulding capacity has been extended to include press-



ings from cellulose acetate sheet, such as the rear lamp body shown in the photograph. In this instance, the lens has been cemented to the main body. We are glad to publicize this expansion.

PLASTICS IN GERMANY

The New Target in Germany is the Science behind the Industries. The following are additional Notes from the Official Reports which can be obtained from H.M. Stationery Office

FIAT Final Report No. 713.—This report deals with the manufacture of cellulose acetate at the works of Schering A.G., which was investigated following a report that Siemens Schuckertwerke A.G. (Berlin) had been making a special cellulose acetate film for cable wrapping said to be outstanding because of its unusual heat resistance. The unusual electrical properties and heat resistance appeared to result from the method of manufacture, the cellulose remaining in "wool" form throughout the process. As a result of this, the theoretical acetyl content is obtained (accounting for the excellent electrical properties), and there is also complete removal of the catalyst $HClO_4$ (which gives the improved heat resistance). The makers of this "triacetat-folie" also claim that the dye used for colouring (Ciba Blue 2R) has a definite stabilizing effect.

FIAT Final Report No. 714.—The casting of "Plexiglas" (methyl methacrylate) is the subject of this report, which includes details of a new method of casting as adopted for the production of sheets for the German aircraft industry where there was the need to make these sheets as optically perfect as possible. The experimental unit produced sheets measuring 0.7 by 1.0 metres, and with any desired thickness. A production of 80 sheets out of 100 with maximum variation of only 2 per cent. in desired qualities was obtained; the old process gave 8 per cent. variation. The success of the process appeared to be largely dependent upon being able to employ plate glass of a particularly high quality as a feature of the casting machine; only one plant (St. Gobain, France) could produce a suitable grade, and it is definitely stated that German plate glass was unsatisfactory. The St. Gobain plant employed the patented Pilkington grinding process in which both sides of the plate are ground and polished simultaneously. In order to re-use methyl methacrylate scrap, Röhm and Haas developed a process for cracking this material and refining the crude monomer, which was subsequently polymerized to the resin. Details of this cracking process are given.

FIAT Final Report No. 722.—German production practice in using Desmodur R as a bonding agent between tyre cord fabrics and their rubber coatings has been studied. Desmodur R is a synthetic adhesive developed by I.G., which, apart from bonding rubber to fabric, has also been used extensively for bonding rubber to metals, thereby eliminating the need for brass plating. Laboratory tests have shown that "doughing" on the spreader gave better adhesions, compared with the original "dipping" process. With dipping, however, there is a greater factor of safety against moisture killing the bonding properties of the Desmodur. For the dipping process, 0.2 per cent. of pure dry Desmodur R in methylene chloride is employed.

BIOS Final Report No. 663.—Information on the manufacture of synthetic resins by I. G. Farbenindustrie at Ludwigshafen is given in this report. The products covered include Plastopals (urea-formaldehyde resins plasticized with the adipates of trimethylolpropane or hexanetriol, in various solvents and concentrations), Luphenes (reaction products of formaldehyde with phenols, cresols, xylenols or butylphenol, plasticized as with the Plastopals), Kunstharze and Phthaloharze. The latter are condensation products of phenol, glycerol and hexanetriol, which are sometimes worked up into other resinous products, much used during the war in oil-free paints and varnishes of which one coat sufficed.

The Microscopic Examination of Plastic Materials

VI.—Mouldings—(c) Comparison of Wood Flours Prepared by Different Methods

By J. H. WREDDEN, F.R.M.S.
(Chief Chemist, Igranic Electric Co., Ltd.)

Continuing an examination of the possibilities involved in the blending of fillers, after having considered the numerous variations in the properties exhibited by the final product due to variations of particle size, shape and nature, the author points out that there are other characteristics, such as specific gravity, which will affect flow properties of the powder and the final density of the moulding, although it should be borne in mind that this characteristic will be affected by those previously discussed. All four factors will influence the specific volume of the powder, and hence have a corresponding effect on the so-called compression ratio, this latter in its turn influencing the flow properties.

IN summarizing the qualities of walnut shell flour as a filler for moulding powders, we are confronted with a curious mixture of flour elements, each differing sufficiently in shape, size and composition, to enable us to regard them as distinct and separate types of elements, each possessing qualities which might be expected to give a different general result were they capable of being used separately as filling material.

When used alone, walnut shell flour is said to produce a high lustre, as can be expected from the presence of the hard particles. These particles also have effect in another direction by lowering the strength of the moulding, and by increasing the apparent density of a moulding powder they have adverse effect on the flow. On the other hand, the high lignin content makes for improved electrical properties and moisture absorption.

In general, this material may be regarded as effecting an improvement in certain directions, but not in others. It would appear that if full advantage is to be taken of these improvements, then it is far better to use it blended with some other filling material possessing advantageous characteristics of a compensating nature. However, as walnut shell flour is more expensive and not so readily available as wood flour, the economic factor affecting the problem will, in all probability, direct its use into channels where it would be used more effectively than would be the case if cheap and easy to obtain.

Let us now revert to a consideration of the effect of different methods of reducing the basic material to flour form. We have seen the result of reduction brought about by chemical pretreatment followed by a gentle mechanical operation, as was illustrated in the case of the coir fibre reduced to its elemental tracheids; in the case of commercially produced walnut shell flour, we have an example of attrition grinding, or pulverizing the basic substances.

Considering the results produced by the two methods on a basic material composed of Swedish softwood, we have illustrated the type of particle produced by the standard method of grinding. (See Fig. 81, "Plastics," May, 1946.) This method depends for its efficacy upon the use of stones, in which one stone rolls against the surface of the other, in this way producing a rolling friction between the grinding members. From this it will be apparent that there is a very widespread differential between the two members, which is actually at the upper limit, capable of being achieved when the mem-

bers are moving in the same direction. If the surfaces are moving with the same velocity relative to each other, no speed differential exists between them; on the other hand, if one surface is moving slightly slower than the other, then there exists a speed differential whose magnitude depends on the difference between the relative speeds of the surfaces in question. As this difference in speed becomes greater, the differential becomes wider until a maximum is reached when one of the surfaces is stationary. This maximum will exist while considering the variation of a differential created by two surfaces moving in the same direction. A further increase in the differential is brought about only by the surfaces commencing to move in opposite directions.

As the reduction of wood flour is carried out in mills having one fixed stone, we may regard the speed differential as being at a maximum. As a result of this, the friction existing between the operative surfaces is a pure rolling friction, which should not be confused with the rubbing friction produced under similar conditions of speed differential, but where the axis of rotation of the moving member is stationary.

When the wood is reduced to sawdust by the employment of rolling friction between stone surfaces, the result is production of bundles of tracheids as already discussed. The cutting action of this process, which is demonstrated by square-cut ends of the flour particles, would appear to be brought about by the surface irregularities of the stones, large particles being produced by a coarse surface and vice versa.

These flours contain only a small percentage of material which can be said to have been "defibrated," and, in view of the nature of the mechanism of reduction, it would be expected that this proportion would be somewhat larger, due to the tendency for the type of friction employed to squeeze out and flatten the particles as well as cut them; but perhaps the explanation of this phenomenon lies in the fact that the mills are invariably kept well fed with a copious supply of raw material in order that the stones are at no time in contact with each other, thus reducing the risk of the contents catching fire.

By ensuring the existence of this cushion of material between the grinding surfaces, the squeezing action of this type of mechanism will be somewhat modified and hence not so effective, inasmuch as the tendency for the particles to be "defibrated" by crushing will be much reduced.

In the case where the axis of the moving stone is fixed, the friction will be seen to be a rubbing friction which will tend to produce a high degree of "defibration" in the particles, but only if the layer of material between the grinding surfaces is thin will this tendency be greatest, and as in this case much damage would result to the surfaces if they were allowed to come into contact, it appears necessary to take precautions to ensure the existence of a fairly thick layer of material between the stones, particularly where the machine runs at high speed, as customary in this country. The continental wood flour grinding mills, on the other hand, employ slow speeds when using stones.

From the foregoing remarks it would appear that something different is required if the wood particles are to be broken down into their component fibres. In the first instance, they are to be reduced to a convenient size, following which they require a squeezing and rubbing action to disorganize the structure and reduce the particles to their histological elements, but this may easily be overdone and result in the production of a flour which is much too fine for use as a filling material.

Let us now examine these specimens with a view to comparing them with those products obtained by the more generally accepted reduction processes.

In this connection the use of polarized light gives a clearer picture of the morphology of the particles. This method of examination is of great use as there are few substances which are completely isotropic (i.e., unaffected by polarized light), and even these become visible in

Leaves from a Moulder's Notebook

This is the second in a series of notes by the B.I.P. Development Department on the problems of the moulder and designer. B.I.P. will send a copy of the first note on request and will welcome comments and enquiries.

Flow Marks—2

The tendency to show flow marks was indicated in our first article as characteristic of translucent moulding materials such as Beetle X grade. The greater the translucency the more noticeable such marks become, even occurring sometimes in mouldings without slots or inserts to interrupt flow.

Slight flow marks, which affected the translucency of the lighting bowl illustrated, were a problem during production. A bowl without a hole moulded in the centre gave far less trouble.

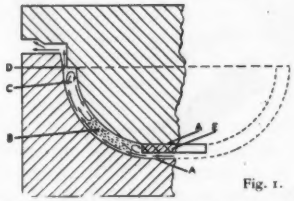


Fig. 1.

ORIGINAL MOULD FOR LIGHTING BOWL—Mould closing: material is forced from between closed faces, 'A' causing a surge of material at 'C' because of the trapping effect of the cut-off at 'D.' The slower-moving inner layer at 'B' is sandwiched and percolation into this mass by the faster-flowing material causes flow marks. Removal of pad 'E' effected a partial remedy and heavy wear at 'D' completed the remedy even after pad 'E' was replaced.

The centre hole therefore became suspect. It was thought that, in the final .010 in. or so of the closing of the mould, the increased flow-speed of the material, as it was squeezed from between the rapidly approaching faces where the hole was formed, had the effect of an injection into the material already forming the wall of the bowl. If that were so it was probable that friction heat, added to the heat imparted by the mould, caused the faster-moving material to reach a stage of polymerisation more intense than that of the rest, and that the flow lines were the result.

The mould was accordingly altered to allow the central hole to be machined as a finishing operation; this did not entirely eliminate the flow marks, but the improvement was so great as to constitute a virtual remedy. However, the cutting of the hole became in its turn a problem, and eventually the mould was brought back again to its original form.

This time the flow marks originally experienced did not return. It was found that the semi-positive fit of the punch into the die was affected by wear to such a degree that no trapping of material occurred at the point of positive location ('D' in Fig. 1). This indicated that the flow lines were caused not so much by the injection effect already suggested, as by the resistance to that injection of the main bulk of the material, trapped by the closing mould. There was a sequel which proved this reasoning. A further mould for the same article was made, and to avoid the pitfalls already encountered an open flash type was designed, with a positive location arrangement between punch and die built well away from the flash point, to try to avoid trapping (Fig. 2). Flow marks, however, were at first as much a problem as before, and it was not until ample sprue grooves were machined into the punch at the point of positive location (Fig. 3) that the trouble was cured and the proof established.

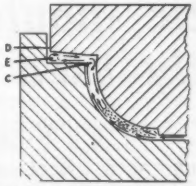


Fig. 2.

Fig. 3.

SECOND MOULD FOR LIGHTING BOWL—Although the cavity locating point 'D,' a point where trapping might occur, was sited well away from 'C' with an overflow space 'E' between, the trouble experienced on the original mould was repeated on this one until sprue grooves, as shown at 'F' in Fig. 3, were incorporated in the punch.

BRITISH INDUSTRIAL PLASTICS LIMITED,
1, ARGYLL STREET, LONDON, W.1.

plastic mouldings rightly used . . .

The illustration shows the 'Systym' electric iron. Body, automatic heat regulator control and handle are made from moulded plastics, giving complete protection to the user. Pilot light and terminal box are housed ingeniously in the handle. Altogether, a carefully planned and soundly made article using moulded plastics in the right way.

Mould manufactured and quantity production of the moulded parts by . . .

DeLaRue PLASTICS LTD

Avenue Works, Walthamstow Avenue, London, E.4. Tel.: Larkswood 2323

Fig. 141.—Softwood flour, 60 mesh, produced by modified grinding method. Mag. 34 diameters, polarized light, system crossed.

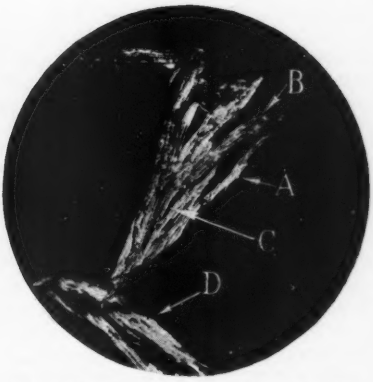


Fig. 142.—Softwood flour, 60 mesh, produced by modified grinding method. Mag. 100 diameters, polarized light, system crossed.

a crossed system, when subjected to stresses in their structure. With regard to the effects of wood and woody tissues, we are fortunate inasmuch as cellulose is strongly anisotropic (i.e., it polarizes well) and hence is quite visible in a system whose polarizing elements are crossed. On the other hand, lignin hardly polarizes at all, in consequence of which it will be seen that we possess means of finding out whether a particular structure is highly lignified or not by merely looking at it under these conditions, although it should be borne in mind that if that specimen is thick or strained, the lignin will polarize more strongly.

An anisotropic substance, when examined under polarized light with the system crossed, appears self-luminous on a black background. This is shown in Fig. 141, where we see a photomicrograph at a magnification of 34 diameters of some softwood flour produced by the new method, the mesh size said to be about 60 mesh. This illustration clearly shows the particle shape to be considerably modified to that found in the standard Swedish softwood flours (see Figs. 81 to 85 incl., "Plastics," May, 1946), inasmuch as this latter material, particularly in coarser grades, generally consists of square-cut bundles of tracheids.

When we examine the flour shown in Fig. 141, the particles are clearly seen to exhibit a much higher degree of structural disorganization; for example, the flour elements indicated at A, B, and C are very much broken down, resulting in a separation of the histological elements, so that the particle may be regarded as a loosely tied bundle of tracheids occurring in a flour of such coarse mesh. This structural disorganization of the particles indicates a powerful rubbing out or "teasing" action in the processing. Particles B and C are also considerably broken down; C is particularly interesting as it is comparatively small, and one tracheid will be seen to be almost completely separated from the main body. Particle D, on the other hand, is strongly reminiscent of those found in the standard Swedish softwood flours, but even in this case the beginning of structural disorganization is evident at either end of the element where tracheids are seen to be somewhat splayed out and the ends of the particle are ragged. However, the majority of particles in this flour are of the types shown at A, B, and C.

Let us now examine this material rather more closely in order to obtain a clearer idea of the nature of this "breaking down." In Fig. 142, we see particle A,

Fig. 143.—Softwood flour, 60 mesh, produced by modified grinding method. Mag. 100 diameters, polarized light, system crossed.

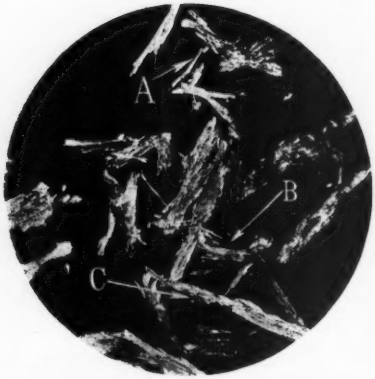


Fig. 144.—Softwood flour, 60 mesh, produced by modified grinding method. Mag. 34 diameters, polarized light, system crossed.

Fig. 141, at a magnification of 100 diameters, under the same conditions of illumination as for Fig. 141. Here something closely akin to separation of the individual tracheids has been achieved; for example, at A there is a single tracheid almost completely separated from its parent body, while at B we see two groups consisting of two (or at the most three) tracheids in a similar state. The entire particle is almost completely divided into two by the separation occurring at C, which condition is more greatly in evidence in the case of the particle marked D.

This illustration demonstrates the great difference between the particle shapes produced by the two methods of grinding. The difference is so great as to amount to a fundamental change in particle shape, due to the newer grinding technique, which would presumably be reflected in the behaviour of this wood flour when used as a filler for moulding powders.

Further types of particles to be found in this flour are shown in Fig. 143, again at 100 diameters, in which A is a particle consisting of a single tracheid, whose length is considerable when compared with its diameter. The whole unit has been bent on itself, and this illustrates a characteristic of this type of illumination, inasmuch as at B the strain patterns resulting from the stressing of the structure of the fibre due to the bending are clearly visible. It will also be noticed that the element C consists of a portion of the bundle of tracheids from which the main portion of the unit has been separated. D is a curious unit which appears to be a portion of a tracheid in which part of one wall has been longitudinally split off, and at E we see another of the bundles exhibiting the splayed ends which are so characteristic of this type.

Thus we have the effects of a defibrating action on wood particles when applied to the production of the coarser meshes of wood flour. A general view of the 60 mesh material is shown in Fig. 144, at 34 diameters under polarized light. This illustration shows very clearly the generally fibrous and irregular nature of the particles; for example, the group marked A is seen to consist of particles almost completely disintegrated into entire and separate histological elements. Another very good example of this is shown by the unit marked B, while at C we have one of the previously mentioned (type A, Fig. 143).

Fig. 144 may be taken as representative of the flour as a whole; it gives a clear indication of the morphological charac-

Fig. 145.—Softwood flour, 80 mesh, modified grinding method. Mag. 34 diameters, polarized light, system crossed.

teristics to be expected of the flour units in general, and one advance which comes to light as a result of this study is the absence of extraneous particles of small size normally encountered in the other wood flours. This may be due to an inherent characteristic of the grinding process; on the other hand, it may be due to careful screening.

One might argue that it could be a simple matter to produce a clean flour such as this, in the coarser grades, whereas the problem becomes increasingly difficult as the mesh size gets finer, in consequence of which the particle size approaches that of the extraneous matter. As the most popular size for filling purposes lies between 80 and 100 mesh, let us examine some of this flour. Fig. 145 shows a sample of this material at a magnification of 34 diameters (same magnification as Fig. 144). Here, the flour is seen to be as consistent in particle size as can be expected, yet still exhibiting its fibrous nature, as shown by units marked A, although at B we see two units composed of bundles of tracheids and not exhibiting any great degree of "defibration." However, this type of flour unit will be seen to be of infrequent occurrence, and any effect they may have on the behaviour of the flour as a whole will be quite small. We also encounter with this sample a somewhat greater range of sizes amongst the particles; for example, the group at C consists of quite small particles of indeterminate shape. These units have not apparently been subjected to the "defibrating" action of the process, which would lead one to suspect that they existed as such in the original sawdust, which (presumably) was the raw material used in the production of this flour. If this is the case, then they are liable to miss the grinding process until such time as this latter has reached a stage where particles of that size come under its influence.

By way of general interest, suppose we endeavour to arrive at a numerical interpretation of the variations of particle size met with in this flour. We may take the middle of the three A particles as the largest, and the particle marked D as the shortest. Particle A, when measured, proves to be 560μ (microns) in length; particle D proves to be 76.0μ. This gives a ratio of lengths of 7.5 to 1, which would appear to be quite considerable.

In order to obtain a comparison of this flour with the standard Swedish material, it is necessary to examine them together. In Fig. 146 we see some Swedish wood flour of the same mesh photographed under the same conditions as for Fig. 145. This illustration shows the great dif-

Fig. 146.—Swedish softwood flour, 80 mesh. Mag. 34 diameters, polarized light, system crossed.

ference between the two types of flour in a general way. For example, we see the high proportion of large square-cut bundles of tissue elements, so characteristic of this material; three very good examples of these are seen at A. The elements shown at B are similar bundles, but the ends show distinct signs of raggedness, and this might be the beginning of defibrations.

Owing to the absence of definite information we can regard the foregoing remarks only in the nature of assumption, but something more positive may be obtained by applying measuring technique to the sample under consideration. In Fig. 146, the longest particle (C) is 480μ in length, while the shortest (D) is 90μ. This results in a length ratio of 5.2 to 1, which figure in comparison with that for the previous sample of flour is seen to be somewhat nearer unity. We are thus confronted with something of an anomaly, because there is obviously a big structural difference between these two flours, yet when it comes to comparing them with regard to the ranges of particle length, we obtain figures which are not as widely different as expected; in fact, the sample which would be expected to show the widest ratio actually possesses the lowest figure.

Something more is required if a figure is to be obtained which can be relied upon to provide a comparative indication of this characteristic. A little thought upon the matter will show that in dealing with the length of the particle only, the effect of bundles of tracheids of the same length, but containing varying numbers of histological units per bundle, was not taken into account. Therefore, the logical result of such reasoning dictates the use of areas rather than length only; thus the area of particle A in Fig. 145 is 0.028 sq. mm. and that for the particle D is 0.00228 sq. mm., from which it will be seen that a ratio of 12 to 1 is established as existing from the largest to smallest particles in the portion of the flour chosen.

In the same way the area of the particle A in Fig. 146 is equal to 0.240 sq. mm.,

Fig. 147.—Softwood flour, 100 mesh, modified grinding method. Mag. 34 diameters, polarized light, system crossed.

while that of particle D is 0.0027 sq. mm. This material now gives a ratio of 90 to 1 from the largest to smallest of particle, so that we see that by using the area shown by these flour particles, we obtain a ratio of 12 to 1 for the material reduced by the newer grinding methods, and a ratio of 90 to 1 for the standard Swedish softwood material. This comparison obviously places these two materials more nearly in their true relationship one to the other, for the figure obtained may be considered as being in the nature of a measure of the constancy of particle size in any particular flour.

Now, as the ideal pure flour would possess particles of exactly the same shape and size, this ratio would in such a case, be equal to unity. Therefore, it will be seen that we have before us a method of defining the variability of particle size in any given flour, against an absolute standard. Thus the figure might be termed the "variability index" of the flour. In the cases under discussion the index figure for the newer material would be 12, while that for the standard flour is 90, from which we may gather that the latter material was some nine times as variable as the former, with regard to particle size.

With regard to this method of establishing the variability index, it might be

argued that the figure is still not a true indication inasmuch as areas only are used, since the functional characteristic of the particle is its volume, a better indication would be a figure based on the volume of the particles. This would be true for coarse powders and would lead to some difficulty in arriving at the truth in such cases, but in cases such as those under discussion, the problem is not so great, because the materials are in a state of relatively fine division and therefore the particle thickness is more constant.

In the cases under consideration this may be taken as being in the region of the diameter of the average softwood tracheid, which is approximately 30μ, or 0.030 mm. This may be verified, in some measure, by reference to Fig. 146, where we see that all the large "A" particles as well as the small "D" particle lie in the same focal plane and are equally sharp, thus indicating near equality of thickness or depth.

The method would consist primarily of taking a number of fields such as that shown in Fig. 145, and measuring the length and breadth of every flour particle capable of being so treated, and an average figure for each dimension obtained, the ratio of the average length to average breadth would then give an indication of the shape of the basic particle of the material under consideration. There are, of course, certain difficulties such as would be encountered in the case of particles of varying breadths, for we have seen that there are instances where considerable variation exists in this direction, but this may be surmounted by taking an average breadth for the particle or taking the greatest breadth. Thus by adopting this latter alternative and applying the method to the flour shown in Fig. 145 we obtain an average particle length of 145μ or 0.145 mm., which result, when taken into consideration with an average breadth of 0.05 mm. obtained by the same means, gives a length-breadth (L.B.) ratio of 2.9 to 1. In the same way the figures given by the standard Swedish flour shown in Fig. 146 show an average particle length of 182μ or 0.182 mm., with an average breadth of 0.73 mm., this in turn giving an L.B. ratio of 2.5 to 1.

In estimating the merits of these flours by this method, it should be borne in mind that the figures obtained are a fairly representative average and it is by no means suggested that the results are highly accurate or that they give an exact indication of the nature of the material. The method is offered in the hope that its use may be of assistance in predetermining the characteristics of any given moulding at an earlier stage of its manufacture and consequently with greater accuracy. It might also be helpful in establishing a greater degree of control over the raw material, and in the choice of it; whereas no greater accuracy is claimed for the method, it can be regarded with confidence as being appreciably better than empirical methods.

It will be noticed that we have only applied planimetric methods to flours of 80 mesh. In the case of finer mesh sizes the same methods will be applicable, but owing to the generally smaller particle size, the use of higher magnifications is advisable in conjunction with a greater number of fields on which readings may be taken, thus keeping the final result as accurate as possible. This is well illustrated by reference to Fig. 147, showing a sample of 100 mesh softwood flour ground by the newer technique.

On examining this material, we see the effects of the grinding process well portrayed, for the flour consists almost entirely of individual tracheids or portions of them, rather than small portions of tracheids bundles and extraneous matter. Three of the large tracheids are shown at A, numerous examples of which will be seen throughout the field; a large proportion of the flour will be seen to consist of small tracheids such as those shown at B; and in general the flour appears to be relatively free from the extraneous dust encountered in earlier samples. It would appear that modified grinding technique has something to offer by way of improvement in the characteristics of wood flour.

(To be continued.)

PATENT REVIEW

The following abstracts have been made from specifications at the Patent Office, with the permission of the Controller of H.M. Stationery Office. Complete specifications can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

B.P. 580,911. Application date: 3.1.44. Accepted: 24.9.46.

Improvements in or relating to the Manufacture of Polystyrene. L. E. Wakeford, D. H. Hewitt and F. Armitage. To: Lewis Berger and Sons, Ltd.

Production of low molecular weight polystyrene by polymerizing monomeric styrene by means of heating it in a solvent. Examples quoted are dipentene and alpha pinene.

B.P. 580,912. Application date: 3.11.44. Accepted: 24.9.46.

Improvements in or relating to the Manufacture of Interpolymers of Styrene with Polyhydric Alcoholic Mixed Esters and of Coating Compositions obtained therefrom. L. E. Wakeford, D. H. Hewitt, and F. Armitage. To: Lewis Berger and Sons, Ltd.

Improvement of B.P. 573,809. It refers to the production of compatible soluble styrene ester polymers by reacting styrene and a partially polymerized polyhydric alcoholic mixed ester in the presence of dipentene or alpha pinene.

B.P. 580,913. Application date: 3.11.44. Accepted: 24.9.46.

Improvements in or relating to the Manufacture of Interpolymers of Styrene with Frosting Drying Oils and of Coating Compositions therefrom. L. E. Wakeford, D. H. Hewitt and F. Armitage. To: Lewis Berger and Sons, Ltd.

B.P. 581,035. Application date: 13.7.44. Accepted: 27.9.46.

Improvements in or relating to the Manufacture of Vinyl Cyanide. C. R. Harris, W. C. Sharpless. To: E. I. Du Pont de Nemours and Co.

B.P. 581,127 Application date: 21.1.42 and 21.1.43. Accepted: 2.10.46.

Improvements in or relating to Water Soluble Resinous Condensation Products. J. D. Morgan and B. Frenkel. To: The Distillers Co., Ltd.

Relates to condensation products derived from phenolic compounds and aldehydes containing reactive methylene groups and in particular to water-soluble thermo-hardening resins. The improvement consists in an increased water solubility achieved by the incorporation of a soap of an organic acid containing at least six carbon atoms per molecule (oleic acid, stearic acid).

B.P. 581,128. Application date: 23.1.42. Accepted: 2.10.46.

Improvements in Electric Cables. H. A. Tunstall. To: Commercial Secretaries, Ltd.

Electric cables capable of withstanding high temperatures, and in particular ignition cables for internal-combustion engines.

B.P. 581,134. Application date: 29.5.42. Accepted: 2.10.46.

Means for Adhesively Uniting Articles. D. A. Harper. To: Imperial Chemical Industries, Ltd.

See also B.P. 580,524 and 580,525. Refers to the bonding of articles consisting of or containing organic di-iso-cyanate modified polyesters or polyester amides, a formaldehyde liberating substance, an acid or a substance which liberates an acid by reaction with the formaldehyde liberating substance at room temperature, and a volatile organic solvent. The substance which liberates acid is a salt of ammonia or primary amine.

B.P. 581,137. Application date: 2.9.42. Accepted: 2.10.46.

Bonding Cured Olefin-polysulphides and related Sulphur-containing Plastics. W. J. S. Naunton, W. E. Roberts and J. T. Watts. To: Imperial Chemical Industries, Ltd.

Bonding of cured olefin-polysulphides and related sulphur-containing plastics by applying to the surfaces a cement consisting of a chlorinated natural rubber, an iso-cyanate modified polyester or polyester amide, with or without formaldehyde or a formaldehyde liberating substance, and with or without a compound containing a halogeno-methyl radicle, dissolved in a low boiling organic solvent. The surfaces are then pressed together and submitted to a heat treatment for setting.

B.P. 581,141. Application date: 17.11.42. Accepted: 2.10.46.

Improvements in or relating to the Plasticization of Synthetic Rubberlike Materials. P. H. Amphlett. To: Dunlop Rubber Co., Ltd.

Plasticization of synthetic rubbers (butadiene-styrene or butadiene-acrylonitrile

copolymers) by masticating under heat a mixture containing the artificial rubber, a plasticizing agent for natural rubber (mercapto-benzthiazole) and a carboxylic acid of the non-soap forming type (benzoic or acetic acid).

B.P. 581,143. Application date: 21.12.42. Accepted: 2.10.46.

Improvements in the Curing of Polymeric Material. J. M. Buist, D. A. Harper, W. F. Smith and G. N. Welding. To: Imperial Chemical Industries, Ltd.

Refers to improvements in the curing of organic di-iso-cyanate modified polyesters or polyester amides.

B.P. 581,144. Application date: 10.2.43. Accepted: 2.10.46.

Improvements in the Curing of Polymeric Organic Materials. W. Furness, L. E. Perrins and W. F. Smith. To: Imperial Chemical Industries, Ltd.

Curing of organic di-iso-cyanate modified polyester amides.

B.P. 581,145. Application date: 24.5.43. Convention date (U.S.A.): 30.7.42. Accepted: 2.10.46.

Improved Process for the Production of Ethyl Benzene. To: Standard Oil Development Co.

Ethyl benzene produced by reacting benzene and ethyl in the presence of a Friedel-Crafts catalyst with hydrogen chloride as a promoter. The hydrogen chloride is recovered by reacting it with additional ethylene to form ethylene chloride, which is recycled and again reacted with benzene in the main reaction zone. The catalyst used is aluminium chloride.

B.P. 581,146. Application date: 25.6.43. Accepted: 2.10.46.

Curing of Polymeric Materials. E. H. Coffey, W. F. Smith and H. G. White. To: Imperial Chemical Industries, Ltd.

Curing of organic di-iso-cyanate modified polyester amides.

B.P. 581,170. Application date: 1.4.42. Accepted: 3.10.46.

Copolymers. To: Pittsburgh Plate Glass Co.

Method of preparation of substantially insoluble and infusible polymers by polymerizing a mixture of a fusible heat-convertible polymer of an organic oxygen compound, the monomer of which contains at least two polymerizable groups and another polymerization material containing at least one of the said groups. Examples of the fusible polymer are esters of acrylic or alpha-substituted acrylic acid and of the organic oxygen compound, esters of allyl, methallyl and crotyl alcohol. Examples of the other polymerizable material are methyl methacrylate and vinyl acetate.

B.P. 581,181. Application date: 7.2.44. Accepted: 3.10.46.

Improvements in or relating to the Welding of Plastics by High-frequency Electric Fields. G. Haim and H. P. Zade.

Low loss dielectric material interposed between welding electrodes for the prevention of sparking in air spaces between adjacent materials to be welded. Also used to control the field strengths in the space between metallic electrodes.

B.P. 581,184. Application date: 21.3.44. Convention date (U.S.A.): 29.1.43. Accepted: 3.10.46.

Improvements in or relating to Electric Insulating Materials and Dielectrics. R. L. Harvey. To: Marconi's Wireless Telegraph Co., Ltd.

Insulating and dielectric material especially suitable for use over a frequency range of at least 10 Mc/s, consisting of a mouldable non-conductive material having a metal (copper or silver) in a finely divided state distributed throughout. The non-conductive material is polystyrene. These materials are mixed in proportions of 10-70 parts by weight of metal to 100 parts by weight of polystyrene. The quantity of metal must be sufficient to ensure that the ratio of reactance to resistance of a predetermined value is kept constant or increased with the frequency of the currents applied.

B.P. 581,210. Application date: 11.5.44. Convention date (U.S.A.): 24.12.43. Accepted 4.10.46.

Bag and Method of making same. To: Wingfoot Corp.

Method of making a square-bottomed bag which will stand erect when empty. It consists of an inner ply of heat sealable material and an outer ply of different composition.

B.P. 581,224. Application date: 11.7.44. Accepted: 4.10.46.

Improvements in or relating to the Bonding of Rubber to Synthetic Resins. H. E. Sampson. To: Hall and Hall, Ltd.

The difficulty of producing an effective bond between rubber and synthetic resins is overcome by first bonding a brass gauze to the synthetic resin core or base during or after moulding, and subsequently moulding a cover of rubber to the gauze.

B.P. 581,251. Application date: 26.7.44. Accepted: 7.10.46.

The Preparation of Unsaturated Oxylates and Polymers thereof. J. W. C. Crawford and F. J. H. Mackereth. To: Imperial Chemical Industries, Ltd.

B.P. 581,255. Application date: 11.8.44. Accepted: 7.10.46.

Improvements relating to Synthetic Articles. C. C. Unruh and W. O. Kenyon. To: Kodak, Ltd.

Refers to copolymers of isopropanyl acetate with vinyl esters. Examples quoted are: vinyl acetate, propionate, N-butyrate, benzoate and chloracetate.

B.P. 581,279. Application date: 4.12.42. Accepted: 7.10.46.

New Derivatives from Polymers and Interpolymers of Ethylene. D. Whittaker and J. S. A. Forsyth. To: Imperial Chemical Industries, Ltd.

Manufacture of oxidation products from ethylene polymers or interpolymers by contacting the polymers or interpolymers either in the molten state or in solution, with air or other oxidising agents (for instance, nitric acid) at temperatures below 250 degrees C. Example of catalyst acting as oxygen carrier—tetrahydronaphthalene.

B.P. 581,280. Application date: 18.9.42. Convention date (U.S.A.): 18.9.41. Accepted: 8.10.46.

Improvements in or relating to the Polymerisation of Methacrylic Acid Esters. To: Imperial Chemical Industries, Ltd.

B.P. 581,281. Application date: 18.9.42. Convention date (U.S.A.): 18.9.41. Accepted: 8.10.46.

Improvements in or relating to the Polymerisation of Vinyl Esters of Organic Acids. To: Imperial Chemical Industries, Ltd.

B.P. 581,313. Application date: 4.9.44. Convention date (U.S.A.): 3.9.43. Accepted: 8.10.46.

Improvements in or relating to the Plasticising of Fabrics and the Production of Laminated Fabrics therefrom. To: British Celanese, Ltd.

Plasticising of thermoplastic fibres (cellulose acetate) in a fabric comprising thermoplastic and non-thermoplastic fibres, by exposing the fabric to an aqueous dispersion of triethyl citrate in the presence of a dispersing agent which is a long chain alkyl sulphate.

B.P. 581,368. Application date: 10.7.43. Accepted: 10.10.46.

Improvements in or relating to the Production of Thermoplastic Materials and the Products obtained therefrom. F. C. Mottershaw, H. Griffiths and W. Saul. To: Semtex, Ltd.

Production of a thermoplastic composition by admixing a polyvinyl compound (polystyrene) and coal tar. The amount of polystyrene may vary from 4-40 per cent. of the weight of the coal tar.

B.P. 581,387. Application date: 21.4.44. Convention date (U.S.A.): 23.4.43. Accepted: 10.10.46.

Improvements in or relating to the Production of Polyvinyl Alcohol Films and Sheets of Reduced Water Sensitivity. To: E. I. Du Pont de Nemours and Co.

B.P. 581,410. Application date: 24.2.44. Accepted: 11.10.46.

Curing of Polymeric Materials. D. A. Harper and W. F. Smith. To: Imperial Chemical Industries, Ltd.

Curing of organic di-iso-cyanate modified polyester amides in uniform admixture with a proportion of a protein.

B.P. 581,421. Application date: 14.4.44. Convention date (U.S.A.): 16.4.43. Accepted: 11.10.46.

Improvements in or relating to the Production of Water-Sensitive Non-Fibrous Sheet-like or Film-like Materials. To: British Celanese, Ltd.

The improvement consists in applying to a water-sensitive non-fibrous material showing permanent shrinkage a surface coating which comprises a water-insensitive film-forming agent (nitro-cellulose, ethyl cellulose, rubber hydrochloride or chlorinated rubber), and subjecting the material so coated to the action of water until water is absorbed in a proportion sufficient to raise the total water content of the base to a value equal to or above the critical range and then removing absorbed water from the coated material whilst maintaining it under little or no tension. This process is applicable to regenerated cellulose, lowly substituted cellulose ether and polyvinyl alcohol.

B.P. 581,439. Application date: 24.2.44. (Divided out of 581,410.) Accepted: 11.10.46.

Curing of Polymeric Materials. D. A. Harper and W. F. Smith. To: Imperial Chemical Industries, Ltd.

Curing of di-iso-cyanate modified polyester amides in uniform admixture with polyvinyl alcohol or partly hydrolised polyvinyl acetate.

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B.P. 581,449. Application date: 30.5.44. Convention date (U.S.A.): 29.5.43. Accepted: 14.10.46.

Improvements in or relating to Pressure-sensitive Adhesive Sheets and the like. To: E. I. Du Pont de Nemours and Co.

Pressure-sensitive adhesive sheet or tape having a pressure-sensitive adhesive coating on one side whilst on the other side a coating is applied consisting of lecithin and in particular of soya bean lecithin. The base film is regenerated cellulose.

B.P. 581,501. Application date: 28.7.44. Convention date (U.S.A.): 28.7.43. Accepted: 15.10.46.

Improvements in or relating to the Production of Vinyl Esters. To: Imperial Chemical Industries, Ltd.

Refers to the catalytic reduction of vinyl esters and in particular to that of vinyl acetate.

B.P. 581,507. Application date: 4.8.44. Convention date (U.S.A.): 4.8.43. Accepted: 15.10.46.

Laminated Articles comprising both Glass and Polymethyl Methacrylate. To: Imperial Chemical Industries, Ltd.

Production of laminated articles by polymerizing between a ply of glass and a ply of polymethyl methacrylate a mixture consisting of 35-65 per cent. of methyl methacrylate, 5-15 per cent. of tetrallyl or tetramethallyl silicate, and 30-60 per cent. of a plasticizer such as dibutylphthalate. The resulting products are able to withstand temperature changes of minus 70 degrees-plus 70 degrees C. without separating or disintegrating. Particularly valuable for aircraft windows.

B.P. 581,525. Application date: 21.8.44. Accepted: 16.10.46.

Improvements in or relating to Compositions suitable for use for Adhesive or Sealing Purposes. L. A. Puddifoot, W. A. Swire and A. D. Woods. To: B.B. Chemical Co., Ltd.

Adhesive or sealing composition consisting of an organic di-iso-cyanate modified polyester amide, a resin of the phenol aldehyde type, and an organic solvent.

B.P. 581,573. Application date: 12.7.43. Convention date (U.S.A.): 16.3.43. Accepted: 17.10.46.

Improved Manufacture of Vinyl Halides. To: Wingfoot Corporation.

Preparation of vinyl halides by passing acetylene and a hydrogen halide over mercury or a mercury halide at a temperature at which any of this vapourized reaction zone will be condensed in another part of the supporting base of the mercury halide. The supporting base mentioned is surface active carbon.

B.P. 581,605. Application date: 18.1.44. Accepted: 18.10.46.

Improvements in or relating to Extrusion Heads for Injection Moulding Apparatus. E. Aron and E. Pollard. To: C.V.A. Jigs, Moulds and Tools, Ltd.

B.P. 581,606. Application date: 18.1.44. Accepted: 18.10.46.

Improvements in or relating to Extrusion Heads or Chambers for Injection Moulding Apparatus. E. Aron and E. Pollard. To: C.V.A. Jigs, Moulds and Tools, Ltd.

B.P. 581,620. Application date: 20.9.44. Convention date (U.S.A.): 21.9.43. Accepted: 18.10.46.

Manufacture of Shaped Structures from Orientated Halogen containing Polymers of Vinyl and Vinylidene Compounds. To: Imperial Chemical Industries, Ltd.

B.P. 581,637. Application date: 19.1.45. Accepted: 18.10.46.

Improvements in or relating to Extrusion Heads for Extrusion Moulding and Injection Moulding Apparatus. E. Aron and E. Pollard. To: C.V.A. Jigs, Moulds and Tools, Ltd.

B.P. 581,642. Application date: 11.12.44. Accepted: 21.10.46.

A Method of and Apparatus for Injection Moulding of Plastic Materials. H. G. W. Chichester Miles. To: Empire Works, Dunstable.

B.P. 581,651. Application date: 29.9.44. Accepted: 21.10.46.

Improvements in or relating to the Manufacture of Compound Sheet Material. J. H. McGill. To: Imperial Chemical Industries, Ltd.

This patent is an improvement on the process claimed in B.P. 570,840. It consists in applying a coating of ungelatinized polyvinyl chloride paste to one of the surfaces of sheet materials to be united, gelatinizing the coating by heat, and applying to one or other of the surfaces a thermoplastic layer consisting of a polymerized unsaturated compound which becomes plastic at a substantially lower temperature than polyvinyl chloride. The sheets with the coatings interposed are then assembled and subjected to heat and pressure.

Planned Mould Maintenance Service Aids Economical Production

Section XXII (cont.)

By W. M. HALLIDAY

As explained in the previous portion of this section, much time can be needlessly wasted when effecting repairs, modifications or adjustments to plastic moulds, if properly designed and constructed equipment is not made available to the toolmaker.

The lack of suitable tools and fixtures may also often become one of the chief causes of damage being inflicted to some vital or delicate portion of a mould mechanism not actually involved in the repair work.

In this present article further helpful illustrations are given of convenient time-saving devices which may be easily and inexpensively fashioned for the use of the mould repairer.

Such tools, etc., will not only save much time by simplifying repairs and handling of moulds, but will very materially assist in rendering these operations far more safe and reliable thereby reducing the risk of causing damage to the moulds.

ONE of the chief points demanding especial care from the toolmaker when undertaking repairs, extensive alterations, or adjustments to a plastic mould mechanism, is so to arrange and conduct the work that the mechanism suffers no damage or injury which will in any way result in its being less efficient as a production tool, or will produce faulty mouldings when eventually returned to production.

The present writer could amply testify from innumerable examples encountered from time to time in his personal mould manufacturing experiences, where a tool has had to be withdrawn from production to undergo some repair, often of a very simple nature, only to find at some stage during those repairs very serious damage has been wrought upon some other portion of the mechanism as a direct result of the use of inadequate or unsuitable equipment.

Such damages usually ranged from badly bruised surfaces of the mould cavity caused by inadvertent blows from a hammer, or heavy objects falling thereon; serious marring of the parting-line surfaces of the blocks due to same causes; badly strained or broken ejectors or cores; destruction of the highly polished surfaces of the tapered sprue channel, or bruising of the spherical seating whereby the mould is located on the nozzle of machine; and numerous other common troubles which space forbids mentioning, but which will be familiar to mould engineers.

This, of course, is one of the foremost reasons why it is highly necessary to equip the toolroom with the required tools and fixtures needed to perform effective and safe repair operations.

For the same reason, it is preferable that all repairs and alterations to moulds should never be entrusted to any but the best skilled toolmakers, and wherever possible giving one individual toolmaker complete responsibility for conducting such repair work, so that, in effect, he will become more or less a specialist in performing adjustment and repair. Where mould repairs are given out at random to any member of the toolmaking staff apparently free to do the work, coupled with lack of good repair tools and equipment, is to increase the risks of possible mould damage.

Continuing the study of effective toolroom facilities for ensuring safe and efficient repairs, a further number of interesting and, it is hoped, helpful devices are depicted and their several uses and advantages explained. These tools have been tried by prolonged practical application and have been found eminently worth while. Usually in toolrooms little organized provision is made for dealing with repairs, and often very

makeshift equipment and tools have to suffice. The tools, etc., to be described will be found vastly superior to such undesirable methods both as regards finished results and time taken to produce such satisfactory repairs.

In dealing with these various fixtures, attention will first be devoted to those specially applicable to the handling of injection-type moulds, those required for expediting repairs, etc., to compression moulds being dealt with later. But before turning to our consideration of these examples it will be most useful to describe a few points affecting mould design and construction which the writer has found to be worthy of the closest attention, since inadequacies in these respects have been found to lead to a large proportion of the usual failures and breakdowns of injection moulds.

It has been well said that the best place to deal with mould repairs is on the drawing board when the design is being developed. Certain it is that experience repeatedly indicates that failures generally centre around a few bad design features, such as the following, which are appended and briefly commented upon for the guidance of readers, who may not be so familiar with the practical problems arising from the use of injection moulds.

Ejector-pin Location

Troubles very often arise in respect of the location of the ejector pins. If these should be incorrectly placed in relationship to the mould cavity, misalignment of the ejector rail may result, which will in turn lead to increasing stiffness in working and perhaps seizure of the rods, or their fracture at the point where they enter the rail. If the diameter of the ejector rods is substantial, misalignment of the kind described will then result in binding of the sliding action of the rail along its guide pillars, strippage of the threads in the rod holes, and increased difficulty in working the mould.

Simple faults, such as the breakage of an ejector rod, if unnoticed, may lead to very serious damage, and many a mould cavity surface has been ruined by the closure of the moulds immediately after an ejector pin has broken, the closing of the blocks causing the broken piece of pin to be jammed within the cavity area.

In those mould designs where the ejector mechanism employs only one or two push rods for operating the ejector rail, much care will have to be exercised to ensure that the push rod or rods by which the rail is actuated are located centrally in relation to the main resistance pressure set up by the rods. Should the push rod be situated out of this pressure area, strong misalignment tendencies will be created, leading to the troubles just mentioned above.

Ejector rods should always be made as large in diameter as practicable, because slender rods are more liable to distort, bend, or break, and also do not serve as well as guidance for the rail. The location of ejector pin positions, as well as the number of pins needed should always be carefully assessed so that the maximum number of pins can be employed for reasons of strength, and also that those portions of the moulding offering the greatest resistance to removal may be provided with ample ejection. Unless this is carefully and satisfactorily covered, rail misalignment can arise with all its attendant snags.

Attachment of Ejector Rods to Rail

Very often numerous troubles arise in connection with the methods of fixing ejector rods to the ejector rail, and it will be recalled that an earlier section dealt with a number of preferable forms of fixing.

One of the chief aims of any particular form or method of fixture of such mould members should be that of affording easiest access for adjustment of the rods in situ. This very often occurs, and slight endwise adjustment of the rods whilst the mould is installed on machine platens will be found extremely convenient, since the actual operation need take no more than two or three minutes, provided the toolmaker can get at the locking nuts or other provisions whereby the rods are fastened to the rail.

Where possible the writer does not advocate the method of fixture of such rods by threading them into the rail, but rather to have clearance holes in the latter member and to a locknut each side of the rail on the threaded shank of the rod. This method ensures that the rod is able to align itself axially with the guide hole in the block and does not require precision drilling of the hole in rail, as demanded with tapped holes. This method will be found very helpful in cases where frequent ejector-pin breakage is encountered due to slight inaccuracies in the drilling or tapping of the holes in rail.

Another frequent cause of ejector-pin breakage is due to the reduction in strength caused by threading same for screwing into the rail. Where it is necessary to have threaded fixture of the pins, a slight increase in rod diameter on the threaded portion sufficient to bring the root diameter of threads not less than the maximum plain diameter of rest of rod will often cure such troubles.

If the ejector rods have to slide within particularly long guide holes in the block, difficulties are often encountered in keeping the surfaces adequately lubricated, and frequent seizures arise. This may often be overcome easily by reducing the diameter of the rod for about two-thirds of its length within the block. This clearance not only reduces the surfaces in contact and the need for lubrication, but also enables lubricant to find its way better to the parts concerned. In addition, any slight inaccuracy in alignment between rail and block guide holes is taken up without producing any tightening effect upon the rod and ejector mechanism as a whole.

Where the ejector pins have to be of two diameters, the juncture of same should never be finished off as a sharp, square step, but rather as a radiused fillet, since this latter formation is considerably stronger and less liable to originate cracks and breakages.

In cases where the toolmaker has to remove broken ejector pins which have seized in the block guide holes, very great care has to be taken to ensure that the removal of such a pin, either by punching or drilling out, does not cause a bell-mouthing of the hole where it breaks through into the cavity area. Should this occur, additional flash will be formed on the moulding and, furthermore, fine slivers of plastic material will be forced between the rod and sides of hole and tend to be drawn back into the hole as the rod is retracted, thereby causing stiffened working of same.

Sliding Core Members

Here, again, numerous similar troubles arise in connection with moulds equipped with sliding or rotating cores, and much that has already been said in respect of ejector-pin mechanisms applies equally to sliding cores.

These members are often operated by purely mechanical means, such as by cams, wedges, rack-and-pinion gearing or pneumatic pressure, or by manual leverage. Unless such mechanisms are located in such a manner that they can exert their greatest pressure or pull at the centre of the greatest pressure area around the core, stiffened working and seizure of the parts may result. Further, it should always be carefully arranged to have the line of pull of all such devices coinciding with the line of draw of the sliding-core piece.

Unfortunately, these two items are often most difficult to determine and check on most types of injection moulds until the tool has been actually mounted on the machine platens, and to obviate these drawbacks the writer devised, and has employed with signal success, the simply constructed bench fixture which is illustrated and described later. Briefly, the objects served by this fixture are to enable a mould, after repairing, to be set up in an identical manner as that imparted by mounting on the machine, and to allow cores and ejectors and mould blocks to be operated just as if the mould were in production, without, of course, passing any plastic material

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through the mould. In this way the toolmaker is enabled to check over the sliding action and bending tendencies, if any, of all cores, and ejectors or other sliding members, quite separately and removed from the machine. This fixture will be described fully shortly.

Dowel Wear and Extraction

Yet another very common source of trouble will be found in connection with dowels on injection moulds. After prolonged usage these tend to wear or become distorted, thus causing mould-block misalignment, opening of parting line and extra flash on mouldings. In such instances it will be desirable to withdraw the mould from production so as to fit new dowels.

In order to eliminate the risks of injury to the parting-line surfaces of the blocks, in particular liable to occur if the faulty dowels are extracted by means of the hammer, the writer urges the provision and use of the simple extractor device (Fig. 1), which has been employed with very good results.

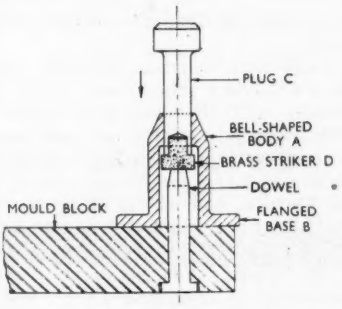

Fig. 1

The diagram shows both the construction and indicates, too, the method of using this tool, which is so made as to be capable of dealing with a wide range of dowel sizes. One merit possessed by this tool is that dowels may be removed without inflicting damage to the end face of same, as usually happens when a hammer or packing block is used.

This device consists of a bell-shaped mild steel member having a bore slightly larger than the biggest diameter of dowel to be dealt with, and, of course, machined deep enough to pass over longest projection of a dowel from block face. This part is shown at A (Fig. 1). The lower end is made considerably larger in the form of a square flange piece as at B. This flange should be turned up exactly square on its bottom face with the bore so that the whole device is able to stand steadily and square as shown.

Sliding freely within the smaller diametered portion of the bore of member A is the hardened cast-steel plug C, which it will be seen is provided with an enlarged head external to bell A. This head should be carefully hardened and tempered and finished off dead flat on the endface. Fastened to the other end is the brass striker D, which is reduced to form a shank for a certain portion of its length and press fitted into a hole drilled centrally up end of plug C. If desired the contact end of this brass striker may be dished out slightly so as to fit snugly on to the domed end of the dowel.

In using this device the mould block is first placed upon a substantially rigid flat surface, and then the bell member A is placed over the dowel, taking care that its flanged end seats squarely on block surface. Then, as desired, a hammer blow may be given to the sliding plug C until the dowel is removed, or a preferred practice would be to place the block underneath a fly-press and exert a steady forcing pressure on the plug C. This latter is actually the safest method.

Dowels can thus be removed quite easily, without trouble and damage to mould surfaces, and, moreover, plugs or packing blocks are not required since these are self-contained within the unit itself, therefore time is usually saved.

Since in most mould manufacturing plants mould dowels are generally confined to only a few different diameters, it is easily practicable to provide a single extractor tool of the kind just described capable of covering the entire range of dowels.

Extraction of Bushings

Very closely associated with the removal of worn or faulty dowels is the need for frequent replacement of worn dowel bushings, or similar hardened replaceable sleeves employed to counteract wear for core seatings, slides, and the like mould units. Here, again, removal of such bushings very often results in damage being inflicted upon other adjacent members or surfaces of the mould from accidental blows from hammers, packing blocks, or knock-out plugs normally employed to remove such a bush.

Fig. 2 shows an extremely simple yet widely adaptable little tool which may be

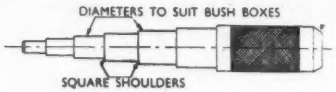

Fig. 2.

employed to facilitate bush removal operations and, at the same time, to safeguard the rest of the mould. This tool is actually a stepped shaft as shown, in this present instance six different diameters of bushing bores are catered for by turning down each step so as to be a close push-in fit within the bore of its appropriately sized bush. The square step at each point of changing diameter is employed for pressing out the bush.

Its use will be readily apparent. The bush to be removed is first cleaned in its bore, then the extractor tool is admitted until the correct step diameter fills the bush, then, by imparting hammer blows or pressure in the fly-press on to the end of the plug, the bush can be removed quite effectively.

The whole tool is hardened and carefully ground on each diameter before putting it into use. One great advantage is that it permits bushings to be removed from the blocks without causing any damage to their bores or endfaces, so that, if desired, the bushes may be used again. It often happens that perfectly sound bushings are irretrievably damaged when extracted by ordinary methods of loose packing plugs of only approximately correct size, since these are rarely held perfectly square with the endface of the bushing, which as a result often suffers injury and bruising.

Sprue Hole Correction

Yet another very common maintenance requirement arising in respect of injection-type moulds is that of maintaining the correct degree of taper and high surface polish on the tapered sprue channel. As will be well known, this channel very often soon loses its original high smooth polish due to the chemical action of some plastic materials employed, or by reason of unauthorized tampering with hard metallic articles when unskilled persons endeavour to remove sticking waste sprue materials which sometimes adhere in the channel.

Sometimes when a mould has been in use for a long period without any substantial overhaul it will be found that the sharp edges of the sprue channel have become worn and corroded away, which feature renders it necessary to remove a small amount of material from the entire surface of the hole in order to restore the correct initial taper as well as surface finish.

Many such instances as these occur when a mould is actually engaged in production, and all-round convenience is often obtained if there is some means whereby such corrections can speedily be performed whilst the mould remains on the machine, and where, of course, the operation entails only a short shut-down period.

The specially adapted sprue channel reamering tool illustrated at Fig. 3 will be found eminently suitable for accomplishing such operations whilst the mould is in position on the machine, and, moreover, the adaptations effected both enable the work to be performed speedily, and, what is more important, ensure that the finished corrected sprue channel will still remain exactly central with the parallel sprue knock-out rod hole in the opposite mould block.

Referring to Fig. 3A, which shows the

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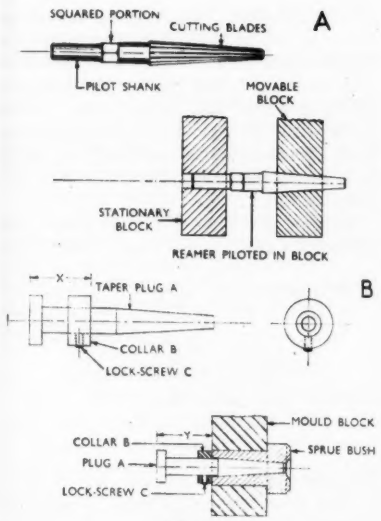

Fig. 3.

cutting tool, it will be noticed that its blade formation follows standard practice. Any convenient number of blades may be provided, the usual number being five on a small tool of this type. These are cut from the solid shank previously turned and ground to the correct taper, i.e., 3 degrees each side. The chief modification lies in respect of the parallel pilot shank left at the opposite end to the cutting blades. The diameter of this pilot portion is such as to be a close sliding fit within the parallel hole in opposite block, and is made amply long enough to engage in this hole when the mould blocks are parted a considerable distance.

At the junction between the tapered and parallel portions the shank is suitably squared to allow an ordinary key or spanner to be used whereby the reamer can be rotated easily.

In use, the mould blocks are first opened their maximum distance, and the tapered end of reamer inserted into the sprue channel to be corrected. Then the movable block is brought inwards a certain amount until the pilot end of reamer engages sufficiently with the parallel hole in the movable block. Then the reamer is used in exactly the normal manner, turning it by means of its squared end until sufficient material has been removed to restore the surface finish or original taper, as the case may be.

It is necessary to use considerable care in making this tool so that the cutting edges are finished off perfectly smooth, as any tiny marks, etc., will be transferred faithfully to the surface of sprue channel and serve to prevent free pull-out of the waste sprue material.

Coupled with the use of this sprue reamer, the maintenance toolmaker should also be equipped with proper taper plug gauges, so that he is able to make a check as desired on the cutting action of the tool, and also for the correct taper on sides of hole. These, of course, should follow closely to standard plug gauge forms, and it is not necessary to illustrate the type of tools in mind. It is somewhat surprising, however, that many toolmaking shops do not appear to have a set of standard taper gauges for ensuring uniformity of taper and diameters of these important mould features.

At Fig. 3B, however, is shown an extremely useful modification made to a standard-type taper plug gauge whereby tapered sprue holes can be very easily checked in such a way to ensure precise duplication of diameters and angle.

The upper view shows the plug A, which is very carefully ground to the correct angle at the forward end, and is provided with an accurate parallel shank portion which terminates in an enlarged head piece as shown. The outside diameter of this head is not important, but the thickness should be made some standard dimension, such as, say, $\frac{3}{8}$ in.

B is a mild-steel collar, made a snug sliding fit upon the parallel shank of the reamer. A locking screw, C, made of brass, is located in a tapered hole through wall of this collar whereby the latter may be locked to the gauge shank in any desired position. The outside diameter of this collar, again, is unimportant, but

the thickness should be $\frac{1}{8}$ in., so that the head and collar together make up exactly to X, or 1 in. The reason for this will be clear by referring to the lower right-hand view in Fig. 3B, which shows the gauge applied to a mould.

Here it will be seen that the mould is equipped with a sprue sleeve, which it is necessary exactly to duplicate, especial accuracy being required in respect of the sprue hole. The collar B is first released and moved backwards up to head of gauge, then the taper portion of gauge applied into the sprue hole, being pushed therein gently until filling. In this position the collar B is then moved towards the mould block until contacting the endface of the sprue sleeve, whereupon it is securely locked to plug shank by screw C. The gauge may then be removed and the distance across collar and extreme left-hand endface of plug head, as indicated at Y, is taken by means of a micrometer measurement, and carefully noted.

When machining out the tapered hole in the new replacement sleeve, the gauge as set is employed and material removed from hole until the face of collar B just contacts the end of bush, at which point all dimensions should be identical with those of the hole in bush being replaced.

This is an extremely useful provision to the machinist and maintenance toolmaker, and the advantages derived make the small outlay in time and expense well worth while.

Extraction of Sprue Channel Sleeve

Many injection moulds are so designed and constructed that it is necessary or desirable to have a separate sleeve member containing the entire sprue channel. This, for example, will be needed where the mould blocks are composite affairs built up from several smaller blocks, whose lines of intersection would normally pass through the sprue channel and thus become points of sticking of the waste sprue after each shot.

In very costly moulds the practice is to use such sprue channel bushes in order to reduce the cost of hole correction when wear takes place. In addition, as pointed out in an earlier section, it is possible for the maintenance toolmaker very considerably to reduce lost production time by planning ahead and making one or two spare sprue bushes or sleeves against the time a replacement is necessary, when the task of exchanging same is only a few minutes' work.

Turning to Fig. 4, which shows the extractor device, it will be observed that

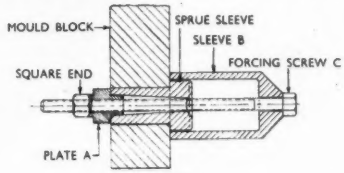

Fig. 4

it consists of a stiff circular plate A made of two diameters as shown. The larger diameter is made 1/64 in. smaller than the outside diameter of the sleeve shank, whilst the smaller diameter is made a free fit within the mouth of the tapered hole, viz., largest end.

This plate is provided with a squared end piece at the opposite side to the step as shown, whereby the plate can be held in the vice, or gripped with a spanner or wrench, as desired. A threaded hole passes clean through the plate located centrally with the outside diameter, and preferably tapped fine pitch of thread.

Member B of this unit is actually a hollow sleeve having an internal bore slightly larger than the outside diameter of the flange at head of sprue sleeve. The end wall of this member is bored out a clearance size to receive the forcing screw C, as shown. This latter part is made of ample length, and has a suitable head for applying a wrench or spanner as required.

From the foregoing description and the accompanying illustration it will be clear how this tool is operated. The mould block is first held vertically in the vice, then the plate A is inserted into the mouth of taper hole at parting-line surface, and the bell sleeve B held in correct position over the flanged end of

sprue sleeve whilst the forcing screw C is inserted through both members and screwed up within plate A. By employing a spanner on the end of screw C a very powerful pull on the sprue sleeve will be obtained and its removal easily effected without incurring any damage either to sleeve or its seating hole.

Since one of the aims of the designer and mould engineer will be to keep sprue channel sleeve dimensions uniform over a wide range of mould block sizes, it will be found in practice that a single tool of the kind just described will in fact serve most requirements.

Locking Fixing Screws

In injection moulds and some compression moulds where the main cavity holding block has to be built up compositely from several smaller blocks closely fitted together, as against the method of machining the entire cavity out of a single block, troubles are very often encountered due to the fastening screws of these sub-blocks becoming slackened off during long production runs.

Such loosening of the various blocks usually occurs as a result of temperature variations and resultant unequal expansion and contraction of the many parts, or through excessive vibration and jarring of the mould during operations.

When this occurrence takes place the sub-blocks become loose and their jointing edges open out slightly, thereby affording entry from fine slivers of plastic material, which, in turn, will cause additional flash on the finished moulded article, and very often troublesome hanging up of the part during the ejection stages of the moulding cycle. Thus additional strain usually falls upon ejectors, which may be broken or badly distorted as a direct result.

Wherever possible means should be provided to obviate such slacking back of all fastening screws, and perhaps the method employed by the writer will commend itself on account of its simplicity, easy performance, and the very means afforded for unlimited removal of screws as and when desired.

The very common practice of peening over the edges of the counter-bored hole in which the head of the retaining screws is housed, so that the latter cannot be drawn outwards, is to be discouraged, since removal of a screw or screws thereby becomes a very protracted and irritatingly difficult business.

Again, some mould makers employ an ordinary spring-type lock washer, inserting same between the head of the retaining screw and the bottom face of its counterbored recess. Whilst this method undoubtedly prevents the screw from slacking back due to vibration, etc., it sometimes prevents it from being extracted by the mould toolmaker having to repair the mould, for the following reason: Such lock washers generally have two opposed prongs, which, when the screw is finally tightened down, obtain a bite into the metal of both screw head and base of hole in block. If some corrosion occurs, or if the screw has been subjected to wide temperature variations causing it to shrink slightly shorter than its original length, the normal bite of the pronged washer is considerably increased, thus making it more difficult to remove a screw.

The method here recommended avoids all the above-mentioned troubles, and yet is inexpensive. Headed screws of the Allen or ordinary cheese-head type are generally employed for such purposes. The recess formed in the block for receiving the head should be machined about twice the depth of the head, and the upper portion of this recess tapped out to receive fine thread locking screw of the "grub" kind. When the main retaining screws have been properly locked down these short locking screws are then threaded into the tops of the recessed portion and locked on to the head of each retaining screw, which thus cannot slack back, but can be readily removed if desired as repeatedly as necessary without injury to either screw.

Another source of trouble very often arising when such holding or retaining screws have to be withdrawn from a mould is that the threaded portions are

found to have corroded fast within the block making it impossible to rotate the screw outwards.

To prevent this occurring, when assembling the mould components for the last time, or after repair operations, the threaded holes should be cleaned out thoroughly to clear particles of grit, moisture, coolant, or other substances likely to accelerate corrosion. Then the screw threads should be liberally coated with a tenacious type of lubricant such as was suggested in the article published last month.

Incidentally, it is worth while emphasizing here in connection with composite mould block assemblies of the kind now under consideration, that all retaining screw-holes, or holes for secondary dowels, pins, etc., needed for fixing and locating such sub-blocks, should never be drilled clean through so as to break into the parting-line surface. If this is not done considerable troubles are likely to ensue for the mould maker having to undertake repairs involving the extraction and replacement of such screws.

With a new mould assembly it is possible to finish off the ends of such screws in holes drilled through blocks so as to make a tolerably unbroken surface on the parting-line, although this is rather difficult since the end thread must be made to run out to a feather edge which will easily be separated from screw.

But if the screw should be removed, it will be exceedingly difficult to replace it and make it fully blank off the hole in parting-line face, and any tiny gaps thus left may become the cause of additional flash formation, marring of cavity surfaces, or sticking mouldings, with resulting increased troubles in ejection.

For these reasons it is far better to make all such holes blind wherever practicable, as this will considerably help the maintenance toolmaker in producing a neat job terminating any repairs, and will also save the expense of using new screws each time.

Another unsatisfactory feature in this same connection, often to be noticed, is the method of fitting such sub-blocks together by means of rivets rather than threaded studs or screws. This method is to be deprecated for the undermentioned reasons.

First, it means breaking through the parting-line face with attendant obstacles towards making a perfectly smooth and unbroken joint; secondly, if ever the blocks have to be parted as for repairs or examination, etc., it is often most difficult to remove such rivets without recourse to drilling them out, which then usually involves re-assembling with larger diameter rivets; and, thirdly, and chiefly because the variations in working temperature of a mould, particularly on some forms of compression tools, is likely to cause such unequal expansion and contraction of the metal as speedily to stretch the peened over ends of the rivets as will soon loosen their respective blocks.

Hand-operated Cores

Sliding or rotating core members are very often actuated by means of separate hand levers, in order the more easily to avoid trapping, fouling or interfering with the movements of other associated members of the mould, which would otherwise be liable to occur if fully automatic operation were provided.

With such hand-operated motions and mechanisms trouble arises as a result of the operator making mistakes in the sequence or scale of such movements, and sometimes very serious damage can be inflicted on other important portions of the mould mechanism.

It is usually easy to arrange some more or less automatic check action or foolproofing of all such movements, to prevent the hand lever, etc., from being operated at the wrong time or to an incorrect degree. It is surprising what careful thought can do in this direction, and the writer could evidence numerous instances where a quite simple device, such as a small latch or lever, built on to a mould mechanism, have completely safeguarded some essential movement and eliminated a recurrent snag.

(To be continued)

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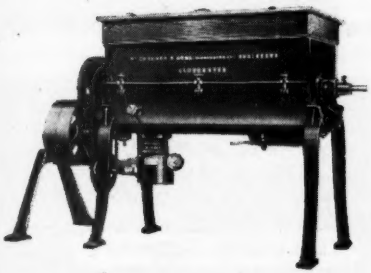

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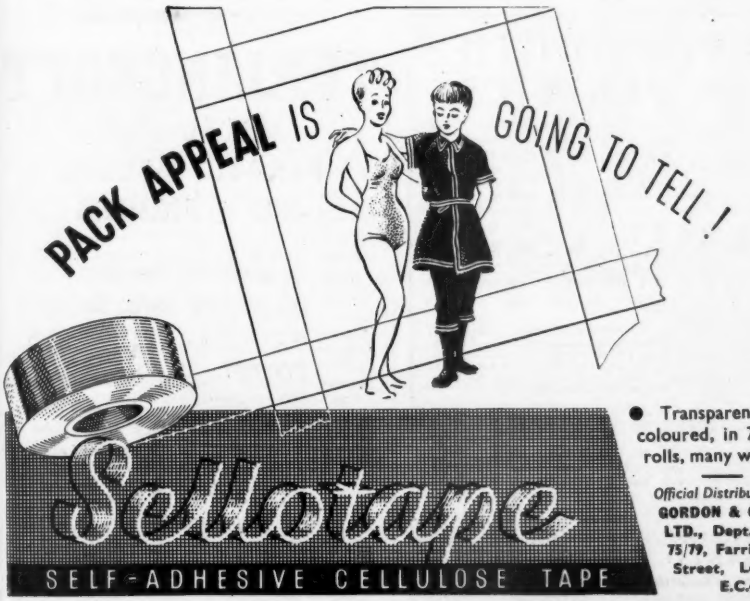

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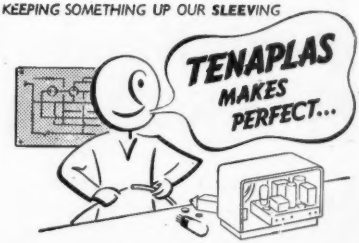

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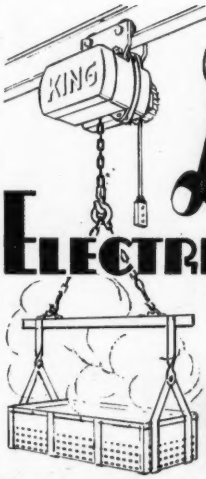

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We are able to undertake certain small runs of plastic moulded products and individual plastic moulded products. Use our services for the preparation of prototypes in plastics. All inquiries strictly confidential. Cottrell and Co. (Plastic Section), 15-17 Charlotte Street, London, W.1. zzz-394

Production Capacity Available and Wanted (contd.)

Wanted, large quantities of plastics toothbrush handles. Samples and quotations invited. Please contact Cawnpore Industries, Ltd., Cawnpore, India, by airmail. 118-x6657

Sales organization are desirous of contacting actual manufacturers who wish to find a market, both home and export, for their products. New good lines, whole production taken. Box 5988, care of "Plastics." 118-x6542

Quantity of plastic moulds, compression and injection, in new condition, for sale. Box 6155, care of "Plastics." 118-x7095

Injection moulding capacity available, 2 to 6 oz. shots, long runs required, preferably using customers' moulds. Write, Box 6119, care of "Plastics." 116-x6967

Cartons.
We are large stockists of new and once used cartons. Once-used cartons in corrugated and fibre-board are carefully sorted and are in every respect equal to new. We would welcome your inquiries. List upon application.

Export cases.
We are able to make any quantity of export case. Delivery within 14 days of receipt of order. A sample case is dispatched before purchase, for test and inspection. For the home market we can make cases to your specification from seasoned converted timber without licence.
Wooden boxes measuring 21c by 12½ by 8 always in stock at 2s. 3d. each delivered London or F.O.R. Full tea chests 4s. 6d. each; half chests 3s. 6d. All clean and sound, coopered or uncoopered.
We can supply gummed tape up to three inches width, and can incorporate the trade mark of your company for a charge of 1s. per coil extra.
Large stocks of paper always in stock, and your inquiries are welcomed.
Our packing service can accept your goods, pack them, see to documents and place on board ship.
If your problem is packing, consult the specialists W. Page and Sons, 34 Langside Crescent, Southgate, London, N.14. Phone, Palmers Green 5087.
Redundant cartons, in first-class condition, purchased for cash. zzz-398

Injection capacity available up to 8 oz. for concerns able to supply own powder, long or short runs. Box 6207, care of "Plastics." 116-x7235

Advertiser wishes to contact firm able to undertake injection mouldings for toys and small domestic articles. Box 6208, care of "Plastics." 116-x6654

Practical lines. As raw materials are in short supply, make the best of your quota; for attractive design on practical lines, consult Hart—Still and Associates, Industrial Designers, 880 Green Lanes, London, N.21. Laburnum 6121. 116-8830

For sale, 0.010-in. thick plasticized cellulose acetate sheeting in 1,000 ft. rolls, in pale flesh colour and clear; also limited amount of 0.160-in. flesh colour. Box 6222, care of "Plastics." 116-22

Perspex for sale. About 280 sq. ft. various thicknesses of transparent and coloured. Details on application. Box 6219, care of "Plastics." 116-19

Various types of plastic materials are stocked by S. R. F. Freed, Ltd. These include various coloured cellulose acetate sheets and clear offcuts, clear Perspex offcuts, assorted colours casein rods, sheets, etc.
We also stock raw animal and vegetable products, e.g., tortoiseshell, horn, cleaned and prepared cattle bones for industrial purposes, vegetable ivory nuts, goose and duck feathers and barrels, etc. 27b High Street, South Norwood, S.E.25. Phones, Livingstone 4042 and Sanderstead 2056. 116-18

Manufacturers of novelty moulded plastic fancy goods invite inquiries from wholesale distributors and exporters. Early deliveries. Principals only. Box 6223, care of "Plastics." 117-9078

Ebonite and bakelite always in stock. Phone, Archway 3654. A. E. Goodeve, Ltd., 188a Seven Sisters Road, London N.7. 121-9075

Perspex. We are stockists of I.C.I. Perspex. Try us for your requirements of clear and coloured sheets. Cuprex, Ltd., 1-3 Robert Street, Strand, W.C.2. Temple Bar 0902. 116-16

For sale, erinoid sheets, 1-5 mm. Write, Box 5143, Frost-Smith Advg., 64 Finsbury Pavement, E.C.2. 116-14

Cellulose acetate moulding powder for sale. Inquiries to Box 6192, care of "Plastics." 116-8

Production Capacity Available and Wanted (contd.)

Engineering firm has to place continuation contract for bakelite compression moulding (80-ton press); moulding tools available. Box 6190, care of "Plastics." 116-6

Mould-making, injection and compression, and moulding capacity immediately available. Box 6195, care of "Plastics." 118-9074

Thermoplastic scrap. We are large buyers of P.V.C. polythene and acetate scrap and offcuts. East Anglia Chemical Co., Ltd., Aycliffe, Darlington. 117-9073

SITUATIONS VACANT

Representative, with extensive connection among users of plain, printed, embossed and fabric-coated P.V.C. sheeting required; trial four weeks part-time on commission. Permanent situation if satisfactory. Apply, Box 4974, care of "Plastics." zzz-392

Toolmaker and Toolroom Turner required for plastic mould work. Must be fully conversant with this type of work, and only first-class men need apply; five-day week. Write, sending full details of past experience and wages required, to Watchett Works, Oakhurst Road, Southend-on-Sea, Essex. 116-8457

Shorthand Typists, Private Secretaries, Clerks, etc. If you are in urgent need of staff, contact Embassy Secretarial Employment Bureau, Excel House, Whitcomb Street, W.C.2. Whitehall 5924. We specialize in efficient personnel. 124-8069

Plastic Technician or Scientist capable of directing research and development required for the utilization of thermoplastic scrap, only applicants with practical experience and high qualifications, in particular with practical knowledge of American methods, need apply. Company wishing to engage applicant intends to reorganize and extend its plastic department and successful applicants would have substantial income, good prospects and permanent position. Box 5368, care of "Plastics." 116-8454

Experienced chemist immediately required by a firm making moulding powders from waste materials and for development of new powders. Box 6225, care of "Plastics." 116-23

Albright and Wilson, Ltd., invite applications for their technical sales staff in the South-eastern area in connection with development of the uses of Dow Corning Silicone products. Applicants should preferably hold a science degree or its equivalent, and be between the ages of 23 and 33. Details of experience and qualifications should be sent to 49 Park Lane, London, W.1. 116-17

Inspector, A.I.D., required, capable of taking charge of department, knowledge of plastics desirable, able to check tools and test laminated material for insulating qualities, five-day week. Salary £6 to £7 per week, according to experience. Box 6194, care of "Plastics." 116-10

Technician required, fully experienced in injection moulding, able to design moulds and put jobs into production, good salary and future prospects to man of energy and initiative. Box 6193, care of "Plastics." 116-9

Important firm of metal manufacturers require an expert on small moulded plastic components to act as consultant and buyer. Box 6189, care of "Plastics." 116-5

Required by leading firm of plastic manufacturers in South-east London area, tool designer with draughting experience, used to compression, transfer and injection mouldings. Write, giving age, experience, etc., to Box M1018, A.K. Advg., 212a Shaftesbury Avenue, W.C.2. 116-1

A few vacancies exist on our staff for first-class representatives to sell fancy goods. Burrell Associated Interests, Ltd., 22 Roland Gardens, London, S.W.7. 116-x6687

Wanted by large progressive company near Buxton, Derbyshire, engineer salesman for marketing technical plastics. Reply stating age, experience and salary required to Box 6226, care of "Plastics." 116-25

SITUATIONS WANTED

Plastics technologist, qualified, desires position, experienced in production, control of production, development. Box 6221, care of "Plastics." 116-21

Technical and commercial manager, plastics division, desires change, specializing in utilization of thermoplastics scrap, development of moulding powders, best connections in industry, up-to-date knowledge of latest American methods, prepared to extend existing or start new company. Box 6218, care of "Plastics." 117-9076

Situations Wanted (contd.)

Plastic technician, capable of organization, design and manufacture, costing and planning, seeks position of responsibility. England or abroad. Box 6099, care of "Plastics." 116-x6934

Works engineer and assistant desires change, prefer anywhere overseas, capable of tool design, maintenance, costing, etc.; both skilled tool makers, at present in complete charge of medium injection moulding factory. Apply, Box 6100, care of "Plastics." 116-x6901

TIME RECORDERS

Factory time recorders, Service rental. Phone, Vigilant 4731. Time Recorder Supply and Maintenance Co., 157-159 Borough High Street, S.E.1. 125-8459

WANTED

Acetate and nitrate. Sheet off-cuts and scrap plastic materials of every description wanted. We can arrange collection. Top prices paid. Lloyds, 72 Bridge Street, Christchurch, Hants. Phone, Christchurch 504. zzz-51

School suppliers require Perspex sheeting cut to stock sizes for craftwork. Sizes required, 12 ins. by 6 ins., 12 ins. by 12 ins., in all thicknesses and colours up to ¼ in.; also wanted, job lots of sheeting, small or large amounts of coloured or clear Perspex off-cuts. Write, quoting details, to Box 5370, care of "Plastics." 116-8709

Scrap; Why not let a well-established firm quote you for cellulose acetate, Perspex, P.V.C. cuttings and other thermo-plastic off-cuts and scrap? Having best use for these materials, highest prices can be paid. Quotations on receipt of representative samples to M. H. Grist (Plastics), Ltd., 82-84 Brighton Road, Surbiton, Surrey. Phone, Elmbridge 4214. zzz-395

Moulding Powder wanted for export, general-purpose phenolic. State specification, colour, etc. Box 5656, care of "Plastics." 117-x5602

Plasticizers. Job lots of the following required urgently: Di-methyl-glycol-phthalate, di-ethyl-phthalate, tri-cresyl-phosphate, tri-phenyl-phosphate. East Anglia Chemical Co., Ltd., Street One, Aycliffe Trading Estate, Near Darlington. 116-8831

Wanted, Perspex sheet and off-cuts, clear and coloured, also casein rod. Box 5893, care of "Plastics." 116-24

Moulding powders. Phenol and urea required in large or small quantities, cash settlement. 45 High Street, Sevenoaks. Phone 4959. 116-15

Wanted, moulds for injection moulding machines 3 oz. and Reed-Prentice 8 oz. Contact Cawnpore Industries, Ltd., Cawnpore, India, by air mail. 118-x6657

Alkathene wanted, either new, reground or scrap for grinding. Box 5987, care of "Plastics." 116-x6543

Wanted, opaque shell-shape reflectors to fit pygmy lamp holders. Box 5868, care of "Plastics." 116-x6278

Offcuts, 1-16-in. cellulose acetate in all colours, not less than 1¼ ins. by 5 ins. Box 6156, care of "Plastics." 116-x7050

Required, quantities of casein, catalin rod, 6 mm.-3½ ins. length or more. Box 6073, care of "Plastics." 116-x6828

MISCELLANEOUS

Monomarks. Permanent London address. Letters redirected, 5s. p.a. Write, Monomarks BM/MONO76, W.C.1. 116-7664

Extend Your Trade.
Use a Trade Mark. Consult
Trade Mark Protection Society,
12 Church Street, Liverpool. 118-6372

Acid containers. High-quality ebonite containers available from stock, 29 gallons capacity, suitable for handling and storing liquid chemicals, price £3 10s. each. United Ebonite and Lorival, Ltd., Little Lever, near Bolton, Lancs. 117-8706

Plastic strips, ¾ in., 1 in., and 1½ ins., various colours in stock. Holden and Hitchon, Ltd., 175 Piccadilly, London, W.1. Phone, Regent 4888. 116-8707

Plastic boards, 1/16-in., specially treated, highest artistic finish, suitable for furniture, bath, splash-backs, etc., plain colours or marble effect; also wood mahogany, oak, walnut; in sheets 8 by 4 or cut to requirements. Prompt delivery. Larks Spraying Process, Monument Hill, Weybridge. 117-x5967

Tubes in ivory casein, suitable for candle lamps, etc. Exchange Electrical 41 Cheetham Hill Road, Manchester, 4. 116-11

Photography by Behr will show your product at its best. Ask for illustrated list. 44 Temple Fortune Lane, London, N.W.11. Speedwell 4298. 121-9072

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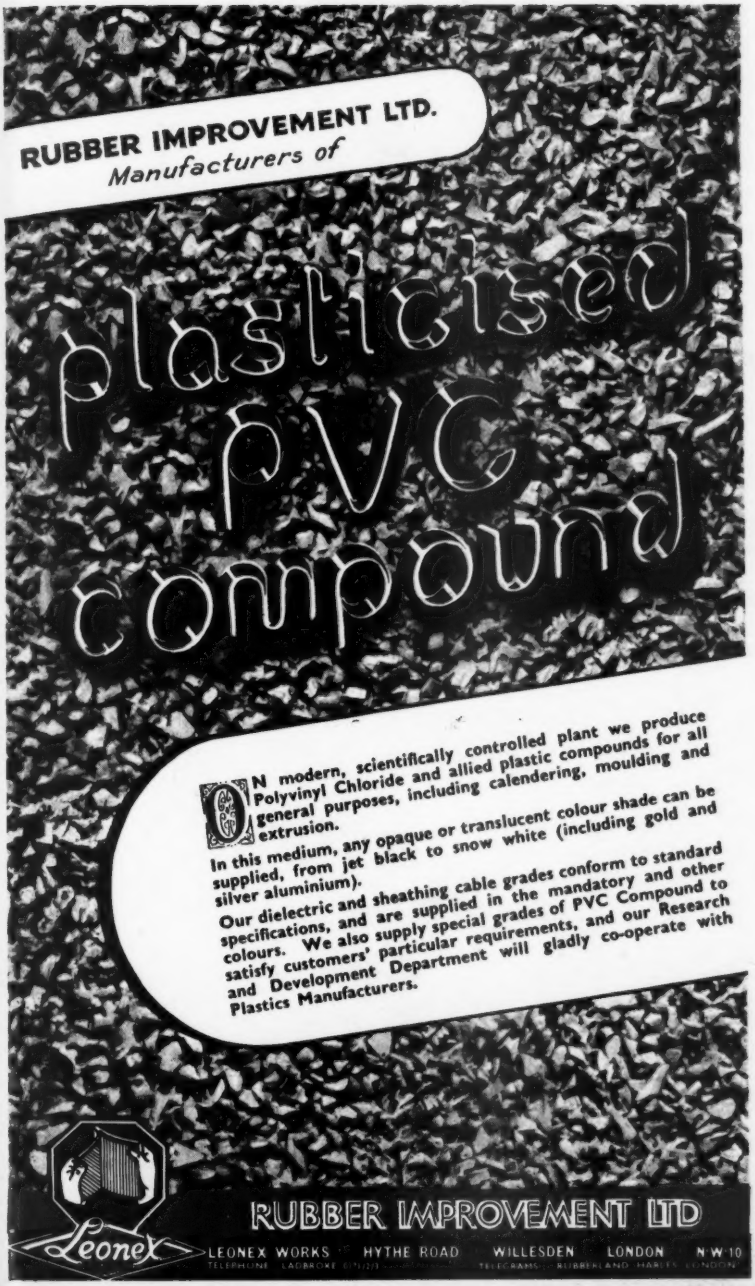
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